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The Decolorization of Glass

By D. J. McSwiney*

Iron compounds are so widely distributed in nature that practically all natural products contain iron in some amount. This is true of the sand and limestone or lime used in ordinary glass. Owing to the necessity for cheapness of the raw materials and to the forms in which the iron is usually present, it is not economically possible to free the sand or limestone from iron before it is used. Part of the iron can, at times, be removed from the sand by magnetic methods at little cost; but it is seldom that the amount removable by this means constitutes a large percentage of the total iron present. The only iron removable from the limestone by this means is that which may have been added to it by the grinding or transporting machinery.

THE term "decolorization" of glass is a misnomer. The desired results, contrary to the idea held by many glassmakers, are achieved by adding more color to the glass instead of taking it away.

The iron contained in the raw materials can, when fluxed into the glass, exist in two conditions; the first known as the ferrous condition and the second, the ferric condition. The color given to the glass by iron in the two conditions varies somewhat with the composition of the glass, but in ordinary soda lime glasses the iron in the ferrous condition imparts a bluish green color to the glass, while that in the ferric condition gives a yellow color. The tint of color yielded by the iron impurities to the glass and the depth of color depend on the amounts of the two forms of iron present in the glass. The process of decolorization consists in the elimination or masking of this color so as to make the glass appear colorless, that is, so it transmits only white light.

The iron in the ferric—or yellow coloring—condition has less than half the coloring power of that in the ferrous—or bluish green coloring—condition; that is, the depth of color will be less than half as strong if all the iron is in the ferric condition than if it is all in the ferrous condition. There is no method, at present known, by which the iron present in the molten glass can be eliminated; the addition of chlorine or bromine compounds to the glass has little or no effect on the amount of iron present. The term "decolorization," as it is used in connection with the manufacture of glass, is, unfortunately, a misnomer in that it suggests the removal of the undesirable iron color. The truth is, however, that the desired results are actually achieved by adding more color to the glass instead of taking it away. An understanding of the fundamental principles involved in the action of decolorizing agents should assist the manufacturer in making proper use of them.

White—or colorless—light is not a simple or elementary color, but is a combination of all the colors of the rainbow combined in certain intensities or amounts; this can be readily seen by passing a beam of white light through a prism by which it is broken up into a band of its constituent colors. If the separated colors be then passed through another prism, they can be recombined to form white light again. White light can be formed by combing two of certain tints of color; such tints are red and greenish blue, also yellow and blue. That is, when yellow light and blue light are mixed, the resulting light is white, or colorless. This, of course, differs from a mixture of pigment colors in which a combination of blue and yellow gives not white but green. Two such colors, which when combined give white, are called complementary colors; the function of the decolorizer is to give to the glass a color complementary to that of the iron color present. When equivalent amounts of two complementary colors are abstracted from white light, the residual light is still white but of lower intensity. Owing to the fact that the color given to glass by iron is not constant, but varies in tint with variations in the amounts of each form of iron present, there is no one coloring material which will always completely decolorize glass; it is usually necessary to use two different coloring materials and to vary

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the amount of each material to conform with the exact iron tint present.

How Iron Colors Glass

When white light is passed into a colored transparent medium, such as glass colored by ferrous iron, the light that passes through appears colored—in this case bluish green—not because the medium adds color to the white light, but because it absorbs or filters out of the white light part of certain of its constituent colors. That is, when white light is passed into glass containing ferrous iron, the light that passes through appears bluish green, not because the iron colored glass adds blue green light to the white light, but because the iron imparts to the glass the property of extracting from the white light little or no green light, more blue light and considerable of the other constituent colors, so that the light which passes through the glass, instead of containing the constituent colors in the proportion to form pure white light, contains a preponderance of green and blue. The light which is absorbed by the blue green glass is a tint complementary to bluish green, i.e. reddish purple. If to a colorless glass a material be added which imparts a reddish purple color to the glass, the action is entirely similar—the glass appears purple simply because the coloring material imports to it the property of absorbing part of the green and blue from the white light, so that the residual light contains a preponderance of those colors which constitute reddish purple.

Now, if to a colorless glass there be added a bluish green coloring material, such as ferrous iron, and a purple coloring material, such as manganese, the color absorbing action of both materials takes place as before; the iron causes a preponderance of blue and green in the light passing through, by absorption of some of the other constituent colors, and the manganese, by a similar absorption, causes a preponderance of reddish purple in the light; but, the two tints are complementary, and combined they give white light, and, if the two coloring materials are present in glass exactly in amounts to give equivalent quantities of the complementary colors, the light which passes through does not have a preponderance of any color and appears colorless. By equivalent quantities of color is meant quantities in the ratio in which they are present in white light, or in which, when combined, they will give pure white light.

—From *"Bottles"*

NO, THIS IS NOT THE INSIDE OF AN ESKIMO'S HOME, BUT MERELY ONE OF THE ILLINOIS GLASS COMPANY'S TANKS AFTER THE GLASS HAS COOLED.

Decolorizing Glass

Two things should be noted—first, that in order to decolorize a glass colored by a definite amount of ferrous iron, a definite amount of active decolorizer is necessary; this does not mean a definite amount of decolorizing agent, as all the decolorizing material added to the glass melt does not become active or effective; it means that there is necessary a definite amount of the material which, when fluxed into the glass, gives a color complementary to the iron color. If more than this amount of decolorizer be used, the glass will be colored by an excess of the decolorizer; if less than this amount be used, the glass will still show the iron color but lighter. Second, that in the decolorizing action a portion of the light is absorbed; when a considerable amount of iron is present, requiring a large amount of decolorizer, the loss in light by absorption is sometimes such as to cause the glass to appear greyish and dull or lifeless. Decolorized glass is never as clear and transparent as undecolorized glass.

Decolorization of the yellow color due to ferric oxide takes place in a manner similar to that of the bluish green of ferrous iron, the decolorizer used giving to the glass a blue color the complement of yellow. The iron in the glass is never wholly in either the ferrous or the ferric conditions, but is always present in both conditions. The resultant color is always a combination of yellow and bluish green, the exact tint depending on the relative amounts of the two forms of iron present. It is because of this variation in tint that more than one decolorizing material is usually necessary in varying amounts. As blue and yellow are complementary, the effect of the yellow of the ferric iron is to neutralize the blue in the color given by the ferrous iron. In this way, one form of iron acts as a partial decolorizer for the other form, and because of this, the color given by iron to the glass usually is green or yellowish green and seldom shows blue unless the glass is melted under strongly reducing conditions, or the iron in the raw materials is almost entirely ferrous. The amount of each form of iron in the glass depends on the relative amounts of each in the raw materials, on the oxidizing or reducing conditions under which the glass is melted, and on the melting temperature. The chemical distinction between ferrous and ferric iron is that the compounds of the latter contain a greater percentage of oxygen, that is, they are more highly oxidized, so that the action of oxidizing materials, such as nitre, manganese dioxide or arsenic oxide is to tend to change the iron from the ferrous condition to the ferric; the action of reducing agents like iron dust, carbon in any form, or organic material such as oil from greasy cullet, dirt, pieces of wood, paper, etc., is to tend to change the iron from the

ferric to the ferrous condition. A short sharp flame with an excess of air acts as an oxidizing agent, while a soft smoky flame acts as a reducing agent. The compounds of ferric iron with glass appear to be somewhat less stable at high temperatures than those of ferrous iron and to tend to change partially to the ferrous condition.

Because of the lower coloring power of ferric iron, and because yellow is more easily complemented than green with less loss in transparency and with less production of off colors, it would be most advantageous for the decolorization to effect the melting under strongly oxidizing conditions; however, this cannot be done in most cases to any great extent because oxidizing materials are considerably more expensive than the ordinary batch constituents and because some decolorizers—in particular selenium—are not effective in a strongly oxidizing batch. Oxidizing agents are to be considered as partial decolorizers in that by tending to change the iron to the form in which it has the least coloring power, they tend to decrease the depth of color given by the iron impurities.

Decolorization of glass by means of complementary colors is limited; the amount of iron the color of which can be masked by this means depends on the decolorizing material use and on the relative amounts of each kind of iron present. Beyond a certain point, the loss in transparency of the glass due to color absorption is so great that the dull greyish appearance produced is less desirable than the iron color; if the exact complementary decolorizing tint is not used with a large amount of decolorizer an off color is very readily produced by the excess color given by the decolorizer over that necessary to complement, especially as, through variations in the melting conditions, the iron color is subject to change; the use of more than a certain amount of some decolorizers tends to give a brownish color, and if this amount is greatly exceeded the brown color produced combined with the dull grey of the poorly transparent glass can give a glass which is almost black in color. The loss in transparency of decolorized glass can be readily seen by looking through a large mass of it, when it will appear to have a greyish cast.

IN the concluding part of this article, which will appear in an early issue, the author describes the action of manganese on the glass, discusses the comparative merits of manganese and selenium as decolorizers, their effect on the tank walls, the functions of arsenic and nitre, and other important and interesting phases of decolorizing.

Decolorizing Agents

The materials available as decolorizers are limited in number; as a complement for the green iron color a material which gives to the glass some tint containing red is necessary. The production of color in glass is a function of elements and not of compounds; i.e., if an element or a compound of any element tends to give a particular color to glass under certain conditions, the probability is that all other compounds of that element will tend to give the same color under those conditions; also, if compounds of any particular element do not give a color in glass under set conditions, it is improbable that any compound of that element will ever be discovered which will color glass. The effect on glass of all the known elements has been tried with the exception of a few that are very rare, and, while their coloring effect is not known in every case under varying conditions, their general coloring action is known. While new elements might be discovered which could be used as decolorizers, they would be too rare to be of practical importance. It is probable that any improvement in the production of cheap colorless glass over present practice will depend on the development of new methods of purifying raw materials, or through better understanding of the development of color by materials at present known.

The Formation of Color

Color is formed in glass in two ways; the first depends on the formation of highly colored compounds usually silicates, which are stable at high temperatures and which dissolve and mix uniformly with the glass; such are the colors given by cobalt and iron. The second type of color obtains when certain materials exist in the glass in the colloidal condition. A substance is said to be in the colloidal condition or in colloidal solution when it is dispersed throughout some medium in the form of particles which are so small that individually they cannot be seen, even by the highest power of a microscope, but which are still much larger than molecules of the substance. In this fine state of division the substance can assume properties different from those it possesses in the ordinary condition; its color, for example can vary widely from its ordinary color. Such colors are those given to glass by selenium and gold.

The elements from which, or from compounds of which, transparent glass colored with some tint of red can be obtained are copper, gold, sulphur, nickel, tellurium, selenium, neodymium, and manganese. Copper and gold give intensely red colored glasses, even when used in very small amounts. The red color in the case of these two elements develops only on reheating and is dependent on the presence of reducing conditions during melting and on other factors which are not clearly understood. The production of an agent to give a red color directly with out reheating, in amounts sufficient to allow it to be used as a decolorizer, is at present impossible, although a better understanding of the formation of color by the materials mentioned above, especially copper, might allow some of them to be adapted to this purpose. It is possible, for example, that a red color for decolorization might be produced by the use of very small amounts of copper in the glass, the actual development of the color being obtained by reheating under definite conditions during annealing in the lehrs; however, such a method would probably require exact control and would be

rather uncertain. Copper in an unreduced condition gives a color similar to that of ferrous iron.

Sulphur ordinarily gives a yellow color to glass, but, under certain conditions, this element and some of its compounds can be made to give a yellowish red color; the production of this color is, however, uncertain, and in most cases in which it does form it is too dense to be used for decolorization. Tellurium has been used to some extent for the production of ruby glass, giving a ruby tending more towards the blue and less towards the yellow than that given by selenium. When, however, it is used in amounts sufficiently small to give a color not too deep for decolorization, the red color does not form readily.

Neodymium compounds give a pink color to glass, and have been used to some exent as decolorizing agents. The color is stable at high temperatures—that is, it does not burn out readily—and is not affected by mild oxidizing or reducing conditions. Neodymium is obtained from a by-product of the manufacture of incandescent gas mantles by means of a tedious and expensive separation. The commercial product always contains varying amounts of its twin element praseodymium from which it is very difficult to separate it completely; this not only decreases the amount of active decolorizing agent in the commercial material, but, as the praseodymium gives to the glass a color nearly complementary to that given by the neodymium, the effect of the latter may be greatly lessened by the presence of the former. The coloring power of neodymium is much less than that of selenium or nickel. Owing to the high cost of neodymium compounds, the difficulty of their production, their variable composition, and their relatively low coloring power, it is doubtful if they will ever take the place of selenium, nickel or manganese to any considerable extent.

Nickel compounds have for some time been used as decolorizing agents in Europe. The compounds ordinarily used are nickel sulphate and grey or black nickel oxide. The coloring power of nickel compounds is somewhat less than those of cobalt, but is very much greater than those of manganese. The color does not burn out, even at very high temperatures, and is stable in the lehrs; it develops best under oxidizing conditions, is stable under mild reducing conditions, but not under strong reducing conditions. The color given by nickel varies widely with variations in glass composition. In a glass containing potash instead of soda, it gives a color similar to that given by manganese, and consequently is valuable for the decolorization of these glasses. In a soda lime glass the color given is a reddish purple, but it invariably has a brownish cast even when the nickel is present in very small amounts. As a result of this, soda lime glasses decolorized by nickel usually have a dirty appearance.

(*To be continued.*)

Notes on the Hardness of Glass*

By Ad. Lecrenier†

For a long time there was no well defined idea on the hardness of substances, and at the present time we have not yet fixed with certainty the scientific definition to be given to this important property of matter. As a further reason we lack practical methods of estimating its absolute value or of translating by exact figures its relative imporance in the comparison of substances.

The best known method still generally used consists in determining whether one substance can scratch another chosen as a means of comparison, or will be scratched by it.

When a pointed piece of a substance scratches a smooth surface of another substance we say that the first is harder than the second.

In this connection, Mohr's scale of hardness is known and is still in current use in mineralogy.

In succession, different methods have been proposed by Crace, Calvert, Johnson, Hugeny Bottone, Pfaff; these methods consist in causing a steel or diamond point to act by pressure on the surface of the substance to be examined by impact, rotation or pressing, and to define the hardness either by the weight necessary to cause the point to penetrate to a certain depth, or by the number of revolutions to impress it under a determined load, or finally by the time required to make it penetrate to a certain depth under a given load. These methods, which certainly constitute an advance over the first, offer in practice serious difficulties in their application; they do not permit any estimation of the absolute value of the hardness and do not lead to any scientific definition of this property.

The credit of having established the first scientific definition of hardness goes to Hertz who, starting with theoretical assumptions, reached results that were verified almost mathematically in practice.

Hertz examined the case of a plate of an absolutely plane, elastic, solid substance in contact not with a point of another substance, but with a part of a sphere with a known radius, of the same substance under known pressure carried to the elastic limit.

Therefore he does not introduce foreign material with the substance to be examined, and he replaces the point which he considers as a solid bounded by a portion of a sphere of extremely small and indeterminate radius by a sphere of known radius. He is thus able to establish the following theory on hardness, the summary of which I have taken from a work of Auerbach,[1] on absolute hardness in which the author tests and corrects the formula given by Hertz.

The contact without pressure of a plane surface and a spherical surface gives a point. If a certain pressure is made to act normal to the plane surface the two surfaces

* Translated for THE GLASS INDUSTRY from *Le Verre*, July 1924, v. 4, p. 149-54.

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[1] Absolute hardness measurements, *Ann. de Phys. & Chem.* v. 43, p. 99.

undergo deformation. The plane curves and the spherical surface flattens out to a certain extent, and thus the point of contact of the two solids is changed to a common surface. This surface is called *pressure surface*, it is not plane and no longer has the curvature of the sphere; its curvature lies between these two values. It depends not only on the curvature of the spherical surface, but also on the relations that exist between the elasticity of the two substances in contact; finally this surface is bounded by a circle.

If the pressure is increased the pressure surface increases also, and the pressure thus is distributed over a greater area. But the compressing of the material evidently does not depend on the total pressure used but on the pressure per unit of surface, and it is important to know how this last value acts as regards the total pressure and according to what law it increases, for it is a fact from constant observation that the pressure per unit of surface increases also. The question of knowing according to what law the pressure per unit of surface increases in relation to the total pressure depends on the law according to which the pressure surface increases relative to the total pressure. Theory shows that the radius of the pressure surface increases as the cube root of the total pressure, therefore the pressure surface itself increases as the ⅔ power of this; it loses as much by the distribution, and the unit pressure increases only proportionally to the cube root of the total pressure. Theory also points out how the pressure spreads out over the surface area; it shows that at any given instant the pressure decreases from the center of the surface where it reaches its maximum, to the edge where it is zero according to the law $\sqrt{1 - x^2}$ (x being the fraction of the radius which the point in question is distant from the center); what has previously been given simply as unit pressure represents only an average pressure that is found with respect to the maximum pressure at the center as 2:3.

If the total pressure increases more and more, this maximum pressure does the same, so that for a certain value of this latter, one of the two pieces (or both, if they are of the same material) reaches the elastic limit. This is shown by a permanent deformation ever after relieving the pressure, if the substance is brittle.

This limit of unit pressure acting normal to the center of the pressure surface, according to Hertz, is none other than the hardness of the material examined.

Apart from the normal pressure of course lateral pressures are set up that can be followed to a certain extent. In the center of the pressure surface they are positive, that is to say in this region the material is subjected to compression on all sides, so that in the case in question we must not expect that a crack will be shown there. But it is not the same in the vicinity of the edge of the pressure surface; here in fact, the lateral pressure is negative, that is to say it is tensile in character. By virtue of the laws of symmetry this tension is distributed in a circular form, we should therefore obtain a crack in a circle about the pressure surface.

For the case in which the two substances are of the same nature but the part of the sphere with variable radii, the theory points out that all things being equal the radius of the pressure surface is directly proportional to the cube root of the radius of the spherical surface and consequently that the pressure itself is proportional to the ⅔ power of this radius. For the same total pressure, the unit pressure and consequently also the maximum pressure are proportional to the cube root of the radius of curvature of the spherical surface. If now, this maximum pressure is the deciding value, its limiting value, corresponding to the elastic limit, should be independent of the radius of curvature.

Therefore the limiting value of the total pressure should be proportional to the square of the limiting radius of the pressure surface, or if from the preceding relations we represent the radius of the pressure surface by the total pressure and the radius of curvature, the limiting value of this total pressure should increase with the square of the radius of curvature.

To state the law evolved, in formulas, we must use the following designations:

ρ is the radius of curvature of the spherical surface in millimeters.
p is the pressure used, in kilograms.
P is its limiting value, i.e. its value at the instant permanent deformation is produced.
p′ is the unit pressure at the center of the pressure surface, i.e. the maximum pressure, expressed in kilograms per square millimeter.
P′ is its limiting value, i.e. the theoretical hardness.
δ is the diameter of the pressure surface in millimeters (as it is determined directly by observation, we take the diameter in preference to the radius).
D is its limiting value in millimeters.
H is its real hardness which, as we will see, is different in comparison with the theoretical hardness.
q is the simplification of the quotient $\frac{p}{\delta^2}$
Q is its limiting value.
f is the area of the pressure surface in square millimeters.
F is its limiting value.
E is the modulus of elasticity of the substance, in kilograms per square millimeter.
r is its elasticity figure, that is the ratio between transverse contraction and longtitudinal expansion.
E′ is the abbreviation of the quotient $\frac{E}{(1-\pi^2)}$

The hardness formula determined theoretically is:

$$P' = \frac{6}{\pi} \times \frac{P}{D^2} = \frac{1}{\pi} \sqrt[3]{\frac{3}{2} \times \frac{E'^2 P}{2}} = \frac{6}{\pi} \sqrt[3]{Pq^2}$$

Auerbach has devised an apparatus for the checking and critical examination of this formula, permitting the direct determination, for transparent substances, of values of ρ and δ.

In this apparatus, a lens of determined radius is pressed upwards from below against a horizontal plate of the same material.

From the upper part of this plate we determine by means of microscope with a micrometric ocular, the size of the contact surface. The apparatus at the same time gives the value of the pressure used.

Practice has shown that the preceding formula does not hold true for different values of ρ; on the other hand we get the same numbers if we multiply this value by $\sqrt[3]{\rho}$; the exact formula for the theoretical hardness becomes therefore

$$H = \frac{6}{\pi} \sqrt[3]{P\,q^2 = \rho}$$

Applying this formula to the examination of the hardness of glasses with well defined chemical composition Auerbach obtained the following results:

Numbers	ρ in mm	E' in kg/sq mm	$F' = \frac{P}{\rho}$ in kg per mm	H in kg/mm 5/3
10	2 5 7	5953	3.0	173
4	1 2 4	5588	4.1	183
2	1 4 12	5871	5.6	210
14	2 5	6811	4.6	217
8	1 3 5	4975	8.8	219
1	3 5 10 15	7107	4.5	223
9	3 5	5677	9.3	244
3	4 12 30	7869	5.0	246
12	2 5	7792	6.4	266
11	2 5	7532	6.9	267
6	1 3 9	6796	9.0	272
5	1 5	7599	7.4	274
13	2 5	6197	11.6	278
7	1 3 5	8192	9.7	316

determined by the Hertz-Auerbach method and hardness as it is generally regarded in glass works. In this industry the word hardness (I speak from the viewpoint of the cutting and not from the ease of hot working) expresses the resistance the glass offers to penetration by the wheel of the cutter. On applying the Auerbach coefficients to glasses of ordinary composition, we find, for example, for lime-soda glass (6 SiO_2 Na_2 CaO), the hardness:

SiO_2	$75.3 \times$	$3.32 =$ 249.99
Na_2O	$12.9 \times -$	$2.65 = -$ 34.18
CaO	$11.8 \times -$	$6.3 = -$ 74.34
		$H =$ 141.47

For crystal glass:

SiO_2	$52.8 \times$	$3.32 = 185.29$
PbO	$35.2 \times$	$1.45 =$ 51.04
K_2O	$12.0 \times$	$3.90 =$ 46.80
		$H = 283.13$

Therefore the hardness of the crystal would be twice as great as the hardness of ordinary glass. In fact, current practice tells us that the opposite is exactly the case.

Besides, we see that in the Auerbach table lead glass

	SiO_2	B_2O_3	ZnO	PbO	Al_2O_3	As_2O_3	BaO	Na_2O	K_2O	CaO	P_2O_5	Mn_2O_3
1	69.0	2.5	..	..	..	0.4	..	4.0	16.0	8.0	..	0.1
2	29.3	..	..	67.5	..	0.2	..	..	3.0	..	..	..
3	70.25	10.0	..	..	..	0.2	..	10.0	9.5	..	..	0.5
4	20.0	..	..	80.0	..	..	..	..	..	..	..	..
5	71.0	14.0	..	..	5.0	..	..	10.0	..	..	..	..
6	70.6	..	12.0	..	..	0.4	..	17.0	..	..	..	..
7	34.5	10.1	7.8	..	5.0	0.5	42.0	..	..	..	..	0.1
8	..	69.1	..	..	18.0	0.2	4.7	8.0	..	..	..	..
9	32.7	31.0	..	25.0	7.0	0.3	..	1.0	3.0	..	..	..
10	41.0	..	..	51.7	..	0.2	..	..	7.0	..	..	0.1
11	..	..	..	..	..	..	..	..	..	..	..	..
12	67.3	2.0	7.0	..	2.5	..	..	14.0	..	7.0	..	0.2
13	58.7	..	..	..	..	0.3	..	..	33.0	8.0	..	..
14	..	3.0	..	..	8.0	1.5	28.0	..	..	..	59.5	..

Endeavoring to connect the coefficient of hardness thus determined with the ordinary process by scratching, Auerbach made scratching tests of different glasses one on another. Unfortunately, in spite of the extreme care given to these experiments, the results of this research were almost nothing, and in every case useless scientifically. It was found, as a matter of fact, that the different glasses examined all scratched one another, the softest scratched even the hardest, and all the tests made to classify the glasses examined according to the importance or the character of the scratches led to no satisfactory result.

Based on the figures given in the preceding table and introducing in a system of equations, on the one hand, the percentage contents of the different glasses, and on the other hand, the practical results obtained for the hardness, Auerbach determined the coefficient according to which each constituent entered into the final value for the hardness.

These coefficients are (averages):

Al_2O_3	ZnO	K_2O	SiO_2	BaO	PbO	P_2O_5	B_2O_3	NaO_2	CaO
10.1	7.1	3.9	3.32	1.95	1.45	1.32	0.75	2.65	6.3

As we see, the coefficients are negative for sodium oxide and calcium oxide.

I wondered if there were not some way of finding out what relation exists between the theoretical hardness de-

No. 10 gives with the practical test hardness 173 although calculation gives 239 or a difference of + 38%.

Calculation therefore giving us nothing certain as to the hardness of the glass, the composition of the latter being known, I tried to ascertain to what extent the operation of cutting glass could help us.

At the same time I tried to find the relation of the result thus obtained, to other physical properties of glass, hardness H, coefficient of tensile and compression strength.

METHOD OF WORKING

In my tests I made use of a machine for mechanically cutting goblets. This machine, equipped with a red sandstone wheel 927 millimeters in diameter, cuts the flat faces of a goblet under constant pressure and always to the same depth, whatever may be the nature of the glass. The time required varies only according to the resistance of the glass and therefore can be taken as a measure of its relative hardness.

In order to have as comparative conditions as possible, I had goblets of different kinds of glass made in the same mold.

I therefore had a series of pieces of the same shape and same volume.

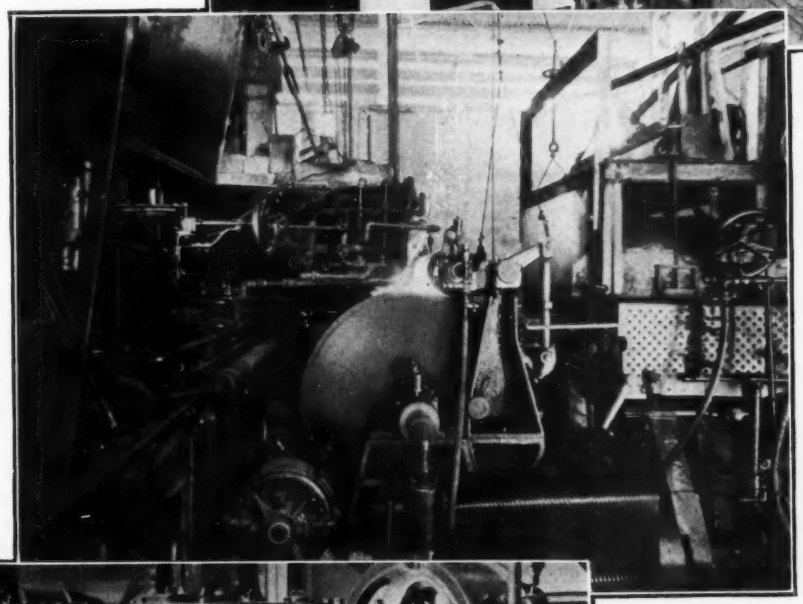
(*Continued on page* 30)

A glimpse into the

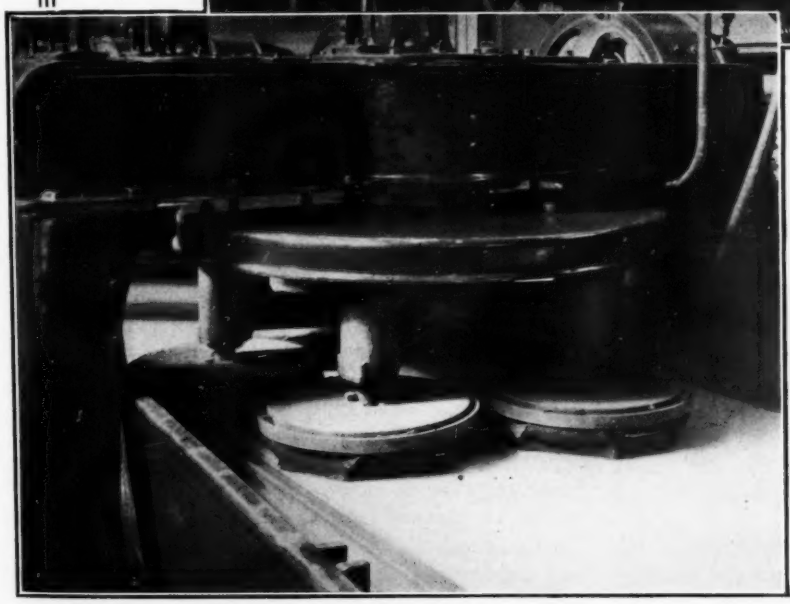
Ford Motor Company's Glassworks

at River Rouge, Michigan

The upper picture is a "close-up" of the glass flowing and rolling operations in the so-called continuous casting process which is the distinguishing feature of the Ford method of making plate glass. The molten glass flows from the melting tank in an uninterrupted stream, passes between two rollers which flatten it to the proper thickness and pass it on to the constantly moving horizontal conveyor which carries it in the form of a wide ribbon of glass through the long annealing lehr, delivering it at the exit end of the lehr ready for cutting to length and the grinding and polishing operations.



The middle picture gives a clear idea of the way in which the tank, rolling machine, and lehr are connected together and operated continuously in unison, in furtherance of the Ford idea of keeping the glass constantly "on the move" from the time the raw materials are fed into the furnace until the finishing operations are completed.



In the lower picture is shown one set of the long row of polishing wheels under which the cut-up plates of glass pass in endless succession and from which they receive their final finish.

After having been annealed a first time in the ordinary annealing furnace, all these pieces were subjected to another annealing in a special furnace. Each annealing time lasted two days. Examined with a Nicol prism in polarized light after annealing, they did not show a trace of tension in any part due to residual hardening. The material tested therefore was perfectly isotropic.

For each experiment we carefully observed with a chronometer the time required, the number of revolutions of the wheel and the weight of each piece before and after the operation. The tests were repeated four to ten times. Each kind of glass had been analyzed and the density was determined with care.

The following tables give the average results of all the tests made and all the related data.

AVERAGE RESULTS OF TESTS

(Total volume removed by cutting = 15 cubic centimeters)

	Calculated density	Density found	Volume per minute in cc	Coefficient of tensile strength	Coefficient of compression strength	Hardness H
1	3.203	3.227	1.696	5.93	85.34	265
2	3.441	3.342	1.593	5.55	80.96	262
3	3.036	3.006	1.301	6.18	86.68	233
4	2.937	2.971	1.069	7.08	89.65	202
5	2.868	2.876	0.964	7.06	77.35	231
6	2.477	2.541	0.933	9.08	91.66	133
7	2.481	2.497	0.888	9.37	87.45	243
8	2.431	2.521	0.854	8.88	91.73	134
9	2.455	2.504	0.794	8.98	93.00	141
10	2.433	2.547	0.754	9.15	92.05	130
11	2.434	2.513	0.733	9.24	93.34	131
12	2.461	2.503	0.544	8.18	89.54	226

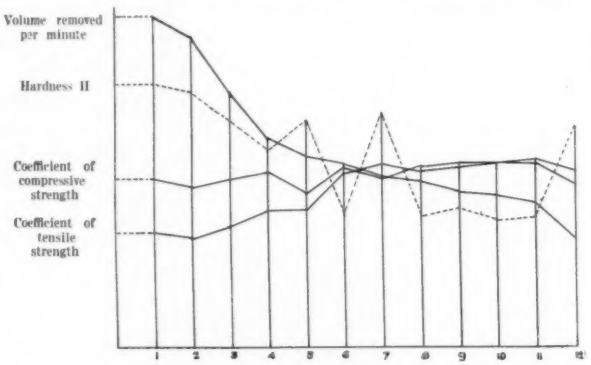
COMPOSITION IN PER CENT BY WEIGHT OF GLASSES TESTED

	Silica	Soda	Potash	Lime	Baryte	Lead oxide	Oxide of iron and alumi-num	Arsenic	Boric acid
1	55.20	...	9.92	...	...	34.81	0.25	trace	...
2	49.17	...	9.39	...	...	41.17	0.25	trace	...
3	58.35	7.87	3.91	...	...	29.42	0.30	0.15	...
4	61.74	7.40	1.38	3.73	...	25.00	0.60	0.15	...
5	61.00	11.24	...	...	26.91	...	0.60	0.15	...
6	71.66	13.85	...	11.48	...	2.41	0.50	0.10	...
7	67.91	...	20.52	10.82	...	...	0.60	0.15	...
8	72.04	17.02	...	10.19	...	...	0.60	0.15	...
9	73.08	15.84	...	10.33	...	...	0.60	0.15	...
10	72.19	15.62	...	11.35	...	...	0.50	0.14	...
11	73.26	14.43	...	11.71	...	...	0.45	0.15	...
12	68.43	15.83	3.40	8.03	...	...	0.65	0.15	2.51

COMPOSITION IN PER CENT BY VOLUME OF GLASSES TESTED

	Silica	Soda	Potash	Lime	Baryte	Lead oxide	Oxide of iron and alumi-num	Boric acid
1	76.87	...	11.34	...	...	...	11.59	...
2	73.53	...	11.52	...	...	...	14.72	...
3	77.08	9.18	4.22	...	...	...	9.30	...
4	78.84	8.34	1.44	3.31	3.31	...	7.63	...
5	76.17	12.40	...	...	...	11.02	...	...
6	77.25	13.19	...	8.60	8.60	...	0.64	...
7	73.32	...	18.18	8.14	8.14	...	...	...
8	76.22	15.91	...	7.52	7.52	...	...	...
9	77.24	14.80	...	7.61	7.61	...	...	...
10	76.53	14.63	...	8.53	8.53	...	...	...
11	77.58	13.52	...	8.62	8.62	...	...	...
12	72.68	14.87	2.95	5.93	5.93	...	...	3.17

It shows from the examination of the preceding tables and the curve drawn, that there is no agreement between the results I obtained and these given by calculation with the Auerbach coefficients. The hardness determined by cutting the glass does not correspond to the theoretical hardness; but as we see at first glance that there is a direct agreement with the coefficients of tensile and compressive strength. The resistance offered by the glass to the cutting by the cutting wheel is greater the higher the value of these two coefficients. This can be easily understood when we consider that the quartz grains composing the wheel first act by compression forcing a corner into the surface of the glass and



then going on almost parallel to this surface by tearing off particles of glass, that is by working this time by pulling on these particles.

As to the influence of the chemical composition of the glass on the hardness as we understand it, we can summarize as follows:

1. In a general way glasses with a soda base are harder than glasses with a potash base containing the same volume of silica.
2. For purely lime-soda glasses, the hardness for the same silica content increases with the increase in lime content and the decrease in the soda content (8-9-10-11).
3. Boric acid gives a great hardness to glass (12).
4. In lead base glasses, the introduction of soda and lime increases the hardness noticeably (1-2-3-4).

Meeting of German Society Glass Technology

The second meeting of the German Society of Glass Technology was held in Dresden on November 28, 1924. Dr. M. Vopelius presided. The meeting was well attended by members and representatives of the federal and state governments, technical universities and scientific societies.

Professor Naegel, president of the technical university of Dresden, stated in an address that the German glass industry is in a period of transition from a purely empirical industry to one based upon strictly scientific principles. He made a plea for closer cooperation between technical men and scientists and pointed out the need of study of related sciences. Dr. Wendler gave an address on the development of glass blowing machinery. The first automatic glass blowing machines were made in the United States in 1872. A description followed of the Owens bottle machine and machinery for the manufacture of electric light bulbs. Dr. Wendler stated that Germany was lagging behind in the field of automatic glass blowing machinery and expressed

the need for greater interest and study of this subject on the part of manufacturers and glass technologists.

Professor Gehlhoff read a paper on the drawing of glass tubes by machinery. He stated that in this line also the German glass industry had not kept pace with the development in other countries, notably the United States. Greater precision and lower cost are obtained by the use of automatic tube drawing machines. A machine of American manufacture produces from 20-70 meters of glass tubing per minute and has an output of 400-500 kilograms per 24 hours.

Dr. Cramer addressed the meeting on the subject of an occupational disease of the eye which is prevalent in the glass industry. This trouble is probably caused by irritation due to light rays emanating from the molten glass. The use of protective eye glasses was advocated.

Dr. Friedmann, member of the Heat Economy Board of the German glass industry, discussed the advantages of the modern glass producer over the old Siemens type. Other papers were by H. Knoblauch, K. Hesse, Fox Maule, O. Graf, Prof. W. Eitel.

Ruby Glass

By Dr. Wilhelm Hannich*

In ruby colored glass nature should be imitated as truly as possible. This is done in the first place with regard to color. However, in the past, the color or coloring substance was difficult to obtain and only few glass makers were able to produce a good ruby glass. At the present time the conditions are entirely different. Gold has been found to be the coloring agent and most glass works produce a high grade ruby glass.

The coloring process consists of a rapid formation of microscopic gold crystals in the glass. When the glass has been heated to a high temperature during the melting process it contains the gold in actual solution. During the cooling process the dissolved gold separates out at the crystalline germs which become enlarged to a size visible by means of the microscope. If the glass is cooled too rapidly only few germs are present and the glass becomes dull. If cooled rapidly to a solid condition it remains entirely colorless. Spoiled glass does not have a red, but a blue or violet color.

In the past ruby glass was made from its components in the glass works and became an article of commerce as a transparent yellow glass. In a subsequent fire the red color appeared. At the present time red colored glass is made in most factories. If the yellow glass has been cooled slowly and gradually and is afterwards pushed into the small oven of the bead maker it becomes a deep red while the other cooler part has not yet changed its color. Glass which has not been cooled properly becomes blue in a sharp fire. The cooler part becomes violet, the still cooler section becomes light rose color, the cold part remains unchanged. These phenomena may be explained by comparing the formation of ruby glass with devitrification. Devitrification is solidification and crystallization of the molten glass. Crystals can only be formed if crystalline germs are present from which they can develop. Crystal formation depends on two conditions, namely the tendency to crystallization and the speed. When a glass is gradually undercooled crystallization increases. If the temperature is far below the melting point crystallization again decreases rapidly. Crystallization can be observed when it becomes visible. This can be obtained by cooling the glass and reheating it to a red heat. The temperature of molten glass in the factory is of course much higher than in the workshop where small objects are pressed. At the high temperature the glass is colorless. The solution is supersaturated with metallic gold. The smallest gold particles form centers around which crystallization takes place. For this reason ruby glass is colorless after the first heating and shows color after the second heating. The largest formation of crystals takes place when the glass is a viscous liquid. The crystalline germs originally formed remain situated in the glass either quite invisible to the eye or scarcely noticeable. During heating the mass is stirred and the dissolved gold separates out around the germs. They increase in size and get a red color. They can be observed with a powerful microscope. If the glass is overheated no germs are formed, not even after it is cooled slowly. If ruby glass is cooled slowly in the glass factory, and is subsequently reheated rapidly in the workshop, it can be shown that the color-giving gold germs have been formed during the cooling process. In slowly cooled glass an excess of saturated gold solution is present. The particles, however, are so small that they have no coloring effect. Coloration goes faster in proportion to the rise in temperature. It takes place at the expense of the dissolved gold. Coloration increases until the supersaturation has disappeared. Careful observation has shown that only a part of the gold is used for coloring; another part remains as a homogeneous solution. If the temperature is raised to 1,400 degrees, the glass becomes colorless and can be reheated after cooling to bring out the color. Often the edges of pressed ware remain colorless while the center becomes beautifully red. This is due to the fact that the edges are cooled more rapidly. They contain therefore only few but larger gold particles than the center of the piece. In the edges the formation of germs is very rapid and only few can develop. On subsequent heating the germs increase rapidly in size. In the center of the piece the germs can form in large numbers. Here the glass is heated slowly so that the germs can grow slowly. Where only few germs can form the glass is spoiled.

The size of the germs is so small that many billions are contained in a cubic meter, and no accurate measuring is possible. The gold particles were measured in a piece of ruby glass which had been moderately heated. The largest measured 1.2 to 6.8 times 10^{-5} which equals a diameter of 4-7 millimicrons. In the parts which were heated to a lower temperature separate particles could not be observed. In colorless ruby glass at room temperature gold is present in two distinct forms, as crystalline germs which grow during heating and give color, and as supersaturated crystalloid solution.

*Friedrichswald, Czechoslovakia.

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The Twentieth Amendment

Widespread interest exists at the present time with regard to the proposed federal child labor amendment. About fifty national and state organizations, including the National Association of Manufacturers and the American Farm Bureau Federation oppose ratification. The American Federation of Labor and the League of Women Voters are in favor of passing the amendment. There is decidedly room for difference of opinion. Both sides can quote statistics in abundance to prove that their contentions are correct. On one side the iniquities of child labor are minimized. On the other side conditions are exaggerated. As is the case in many controversies both sides are able to advance arguments which cannot easily be refuted.

There cannot be any question as to whether or not existing evils of child labor shall be tolerated. No one in this age will undertake to defend exploitation of any class of workers. It is only a question as to how results should be obtained which are fair to the children themselves.

It may be well to review briefly the history of federal child labor legislation. On September 1, 1916, Congress passed a child labor law intended to prevent transportation in interstate commerce of products made with the help of child labor. The Supreme Court held the law unconstitutional. Three years later another child labor law was passed, which imposed a special tax on employers of child labor. This law also was found to be unconstitutional. It became evident that if Congress would obtain the desired power the constitution must be amended. The amendment passed on June 2, 1924, reads:

"Congress shall have power to limit, regulate and prohibit the labor of persons under eighteen years of age.

"The power of the several states is unimpaired by this article except that the operation of state laws shall be suspended to the extent necessary to give effect to legislation enacted by Congress."

The passing of the child labor laws of 1916 and 1919 did not excite any such widespread opposition as the proposed amendment for the very good reason that laws can be changed or repealed, whereas an amendment to the constitution is practically irrevocable. In the meantime the Prohibition Amendment has given the people a taste of the ways and means of federal bureaucracy. They decidedly do not care for more.

There might be an argument for further extension of federal power if it could be shown that the states have neglected to regulate child labor. But this is not the case. Every state in the Union has passed child labor legislation. Employment of children under 14 years of age in gainful occupations is prohibited in thirty-six states. Six states have labor restrictions applying to children up to 15 years of age. Then why is it necessary to duplicate existing agencies? Is Congress able to do better than state legislatures? Granting that state laws have failed in certain instances to give full protection, can Washington expect to create ideal conditions everywhere? We fail to see the reason why Congress should be given the right to further usurp state power. An enormous amount of money will be needed to police the thirty million persons which would

come under the care of federal agencies. If once granted to exercise authority, Congress has never failed to use it to the fullest extent regardless of cost and annoyance produced thereby. The present plight of the industrial alcohol industry is a case in point. The harassment of legitimate industries using alcohol in their manufacturing processes is too well known to require expostulation. Industry for one does not desire any further federal supervision.

Those who argue that the time of persons under 18 years of age should be occupied by educational pursuits overlook the fact that millions who are unable to absorb a high school education become successful men and women through practical experience. Several trades cannot be learned unless practice is begun at an early age as apprentice. To prevent youths from earning and learning and to enforce school attendance beyond a reasonable age will be to encourage idleness. It will tend to increase the already alarming contempt for law and order existing at the present time. The Twentieth Amendment to the Constitution should be rejected and all legal means should be used to prevent its ratification.

[EDITORS NOTE:
Since the above was written the number of states that have rejected the Twentieth Constitutional Amendment has increased sufficiently to make its adoption impossible.]

Technical Consultation Service

QUESTION 65. BATCH FOR MAKING BOTTLES BY AUTOMATIC MACHINES. We have a sand of the following analysis, also lime as listed, and desire to use this material, if possible, in the making of beer and wine bottles, to be made on automatic machines, in conjunction with flowing device.

We wonder if you could give us a batch recipe wherein these raw materials may be used, and suitable for the above conditions:

LIMESTONE

Insoluble	.50%
Alumina and iron oxide	.61 "
Lime	53.02 "
Magnesia	trace
Loss on ignition	45.99 "

SAND

Silica	75.50%
Alumina	7.80 "
Iron oxide	2.23 "
Lime	4.10 "
Magnesia	1.90 "
Sodium oxide	1.30 "
Potassium oxide	0.91 "
Water	1.10 "
Loss on ignition	5.40 "

ANSWER: With the raw materials as given it will be impossible to obtain a glass having the composition most desirable for machine bottle glass, which is as follows:

Silica	75-75.5%
Lime	7- 8 "
Sodium oxide	16-18 "
Iron oxide and alumina	1- 1½"

However, it is probable that a glass of somewhat different composition may yet prove to be workable by machinery and we have tried to get a combination which approaches the standard composition. Such a batch is the following:

Sand	1,000 lbs.
Soda ash 58%	250 "
Limestone	100 "

This batch will give a glass of about the following composition:

Silica	66.52%
Iron oxide	1.97 "
Alumina	6.87 "
Lime	8.28 "
Magnesia	1.67 "
Sodium oxide	14.72 "

This would be an excellent bottle glass and if blown by hand it could hardly be improved upon. But there is an element of uncertainty as to how glass of this composition would act in a flowing device. For this reason we would advise to try out this formula on a small scale, and not to fill up a tank with glass of this composition until it has been found to be suitable. The use of cullet having the standard composition would tend to improve the glass.

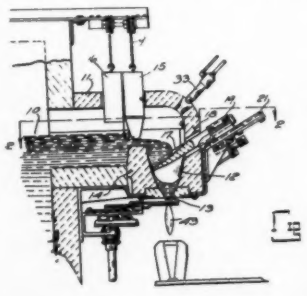
It is quite evident that the sand is mixed with a considerable quantity of clay, which probably could be removed by washing. This, of course would simplify the problem considerably.—J. B. K.

Recent Patents

NEW INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

Complete copies of U. S. Patent Specifications may be obtained from the Commissioner of Patents, Washington, D. C. Price 10c each

MEANS FOR FEEDING MOLTEN GLASS. 1,520,229. Dec. 23, 1924. Enoch T. Ferngren, Toledo, O., assignor to the Owens Bottle Co. Filed 10/17/21. An object of the invention is to provide suitable means to periodically vary the depth or head of glass within the discharge chamber and thereby control the discharge. The glass is permitted to issue under a comparatively high head of glass within the discharge chamber to form a suspended gob. The head of glass is then reduced, thereby reducing the pressure acting to expel the glass, and the suspended gob is severed at a point a short distance below the outlet. When the head of glass is again increased after a suitable time interval, a comparatively rapid flow or extrusion is again established, owing to the increased expelling force due to said head.



PROCESS OF MAKING GLASS BLANKS FOR PARABOLIC REFLECTORS. 1,519,277. Dec. 16, 1924. William H. Taylor, Ford City, Pa., assignor to Pittsburgh Plate Glass Co. Filed 6/5/22. The process of making glass blanks for parabolic reflectors, which consists in regrinding the surface of a sheet of plate glass to reduce such surface to a plane, bending the plate so that the reground face of the plate becomes the convex face of the bent blank and so that such convex face is of the exact parabolic contour desired, and then surfacing such convex face using said face as a guide and maintaining the curvature substantially the same during the surfacing.

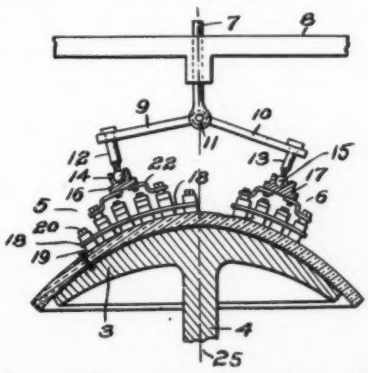
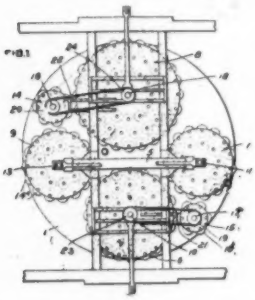
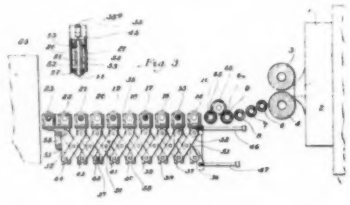


PLATE-GLASS-POLISHING MACHINE. 1,520,766. Dec. 30, 1924. George W. Oakes, Crystal City, Mo., assignor to Pittsburgh Plate Glass Co. Filed 5/21/21. In combination in a plate glass polishing machine, a circular driven table adapted to carry the glass, a pair of circular polishing runners whose combined diameters approximate that of the table mounted above the table with their polishing surfaces in opposition to the surface of the table and adapted to rest upon the glass on the table and be rotated by their frictional contact therewith, a pair of smaller polishing runners located with their axes of rotation adjacent the edge of the table, and means for rotating the smaller runners from the larger ones.

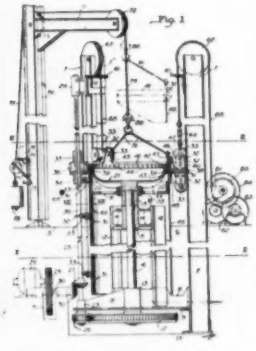


ROLLER TABLE FOR GLASS MACHINES. 1,519,244. Dec. 16, 1924. Albert E. Evans, Pittsburgh, Pa., assignor to Pittsburgh Plate Glass Co. Filed Jan. 22, 1924.

The combination with means for continuously forming a ribbon of glass, and a lehr in alignment therewith for receiving it, of an intermediate roller table, comprising a plurality of spaced rolls, a slideaway extending under the series of rolls at each end, bearing members for the rolls slidably supported on the slideways, means for fixing the end bearing members with respect to the ribbon forming means and lehr respectively, and lazy tong connecting means between the end bearing members and the other bearing members whereby the spacing between the rolls carried by the bearing member is maintained uniform as the end bearing members are moved in and out.

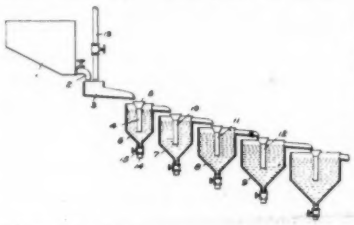


METHOD OF AND APPARATUS FOR MAKING GLASS. 1,523,157. Jan. 13, 1925. Walter O. Amsler, Pittsburgh, Pa. Filed 4/25/21. An object of the invention is to provide a new and improved method and apparatus utilizing centrifugal action in the formation of glass cylinders or other hollow glass articles rather than the well known drawing and blowing operations, thereby doing away with the compressed air plant. Among the claims made is the method of forming hollow glass articles which consists in rotating a mass of molten glass in a receptacle and thereby centrifugally cause the glass to flow outwardly over the edge of the receptacle, freezing the first of the overflow to a bait ring rotating with the receptacle, and then moving the bait ring longitudinally of its axis of rotation while maintaining the ring and receptacle in rotation.



PROCESS OF MAKING HIGH-GRADE GLASS. 1,522,697. Jan. 13, 1925. Charles E. Parsons, New York, assignor to Metal Research Corporations. Filed 10/17/23. The process relates to a method of making glass from blast furnace slag which consists in finely dividing said slag; digesting said finely divided slag with a solution of sodium silicate to form calcium and magnesium silicates and sodium aluminate; separating out said calcium and magnesium silicates; adding to said calcium and magnesium silicates such constituents as are necessary to complete the desired glass making charge; and forming the glass from the charge material thus provided.

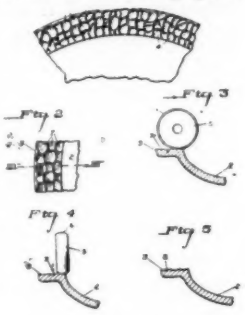
PROCESS FOR GRADING ABRASIVES. 1,519,250. Dec. 16, 1924. Frederick Gelstharp, T[illegible]ntum, Pa., assignor to Pittsburgh Plate Glass Co. Filed June 23, 1921.



The process of grading inorganic abrasives such as the emery used in smoothing plate glass, consisting in subjecting a mass of abrasive to a liquid flow in the presence of gum arabic as a deflocculating agent and collecting separate size grades of the abrasive as suspended thereby, the grains of the different grades being of substantially the same composition.

METHOD OF DECORATING GLASSWARE. 1,518,930. Dec. 9, 1924. Gustav A. Horn, Jeannette, Pa. Assignor to Westmoreland Specialty Co. Filed 4/7/24. The method of decorating glassware in imitation of hammered metal consisting in grinding the surface to provide an area composed closely adjacent facets, each having a different outline and variant concavity, then covering the same with a suitable pigment, and then baking the ware.

In carrying out the process, the surface of the object is ground against a rotating cutting wheel with a convex surface and transverse curvature, at various angles or positions changing the direction of rotation of wheel more or less for each individual cut.



METHOD AND APPARATUS FOR DELIVERING VISCOUS GLASS. 1,516,220. Nov. 18, 1924. Oliver M. Tucker and William A. Reeves, Columbus, O. Filed 9/23/24. Glass being delivered through a spout is very liable to develop strata of different temperatures and the charges will frequently curve, because one side is colder than the other or will be otherwise of uneven consistency. The inventors claim to have solved the bothersome problem by first providing a spout which is thoroughly insulated and then equipping such spout with means whereby the temperature of both the spout interior and the glass can be efficiently regulated. Among their claims is a spout for delivering viscous glass from a furnace comprising a channel block, an outer lining for said block, a channel in said lining adjacent to the juncture of said spout with the furnace wall, said lining being spaced from the furnace wall to provide a space open to the atmosphere between lining and the furnace wall.

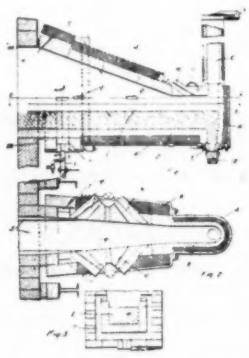
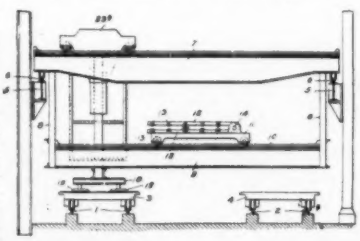
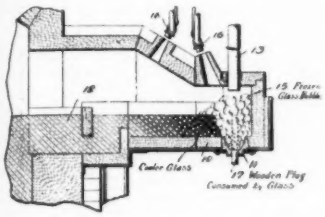


PLATE-GLASS-TRANSFER APPARATUS. 1,519,256. Dec. 11, 1924. Herman S. Heichert, Pittsburgh, Pa., assignor to Pittsburgh Plate Glass Co. Filed 12/5/23. Apparatus for transferring glass sheets from one car or carrier mounted on a track to another car or carrier on a parallel track to one side of the first track and turning it over, which comprises a vacuum lifting frame, a U-shaped turnover frame adapted to receive the sheet to be transferred through its open side, when such sheet is lifted by the vacuum frame and such frame and the turnover frame are given a relative lateral movement, and overhead means for raising and lowering the vacuum frame and for



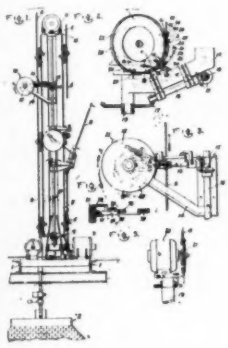
shifting such frame from a position over one track to a position over the other track.

METHOD OF DAMMING FLOW OF MOLTEN GLASS. 1,519,802. Dec. 16, 1924. Alexander Samuelson, Terre Haute, Ind., assignor to William R. Root, Terre Haute, Ind. Filed Aug. 20, 1923.



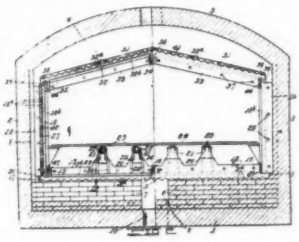
The method of damming out-flow of molten glass, or similar material through a downwardly directed passage which consists in projecting a plug of combustible material, such as wood, upwardly through the outlet and into the molten glass, thereby forming between the supply of glass and the outlet of the passage, a mass of congealed bubbles of glass.

GLASS-CUTTING APPARATUS. 1,522,271. Jan. 6, 1925. Francis J. Rippl, Cleveland, O., assignor to General Electric Co. Filed 11/6/19. This invention has special application in connection with apparatus for drawing cane glass and glass tubing particularly of the type set forth in the Fagan Patents Numbers 1,273,345 and 1,273,346. The inventor claims a combination with an abrasive wheel, means for rotating said abrasive wheel to score cane glass or glass tubing, means for holding said cane or tubing against said abrasive wheel, said means comprising a guide, an arm to engage said cane or tubing to hold it in said guide, means for causing said arm to engage said cane or tubing and means for causing said arm to disengage said cane or tubing and means for cracking-off said cane or tubing.

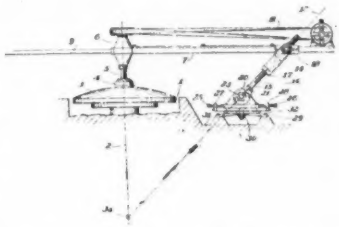


GLASS SPONGE AND PROCESS OF MAKING SAME. 1,515,653. Nov. 18, 1924. Axel E. Bertelson, New York, N. Y. Filed 11/7/23. A process of making a sponge-like product which comprises mixing glass wool with a salt which is substantially inert to glass, heating sufficiently to sinter the glass, cooling and leaching out the salt.

MUFFLE GLASS FURNACE. 1,520,408. Dec. 23, 1924. Phillip Ebeling, Bellaire, O. Filed 9/9/21. A muffle furnace comprising outer furnace walls and a crown, and a muffle extending longitudinally through said furnace and spaced from the latter to provide a combustion chamber and muffle encircling flues leading from said chamber, said muffle consisting of a bottom, side walls and a roof, each composed of a plurality of rigidly connected cast-metal plates, the wall plates being carried upon the outer ends of the bottom plates, and the outer ends of the roof plates being seated upon and interlocked with the upper ends of said wall plates, and a refractory coating carried exteriorly by the plates of the side walls and the roof.



MACHINE FOR SMOOTHING CURVED SURFACES. 1,520,703. Dec. 30, 1924. Gustav E. Ericsson, Ford City, Pa., assignor to Pittsburgh Plate Glass Co. Filed 8/23/24. In combination with a rotatable table adapted to carry a sheet of glass having a curved surface to be surfaced, a supporting frame over the table, a spindle mounted for rotation on the frame and substantially perpendicular to the surface of the glass means for rotating the spindle also carried by the frame, a surfacing device on the spindle, means for supporting the frame for oscillation on an axis inclined to the axis of rotation of the table and cutting such axis, and means whereby said last means may be adjusted to vary the angle of inclination of said axis of oscillation and whereby said axis may be adjusted bodily toward or from the table.



Arsenic in 1924

Production Broke All Records. Prices Dropped Fifty Per Cent

The production and sales of arsenic in the United States in 1924 broke all previous records, according to a statement just issued by the Department of the Interior. Nine companies that produced white arsenic in the United States in 1924 reported to the Geological Survey their sales, which amounted to 14,500 short tons. The sales of the crude and refined product represented 71 per cent of the total white arsenic produced. The products sold at an average price of 9 cents a pound.

Imports by Months

During 1924 about 9,000 short tons of white arsenic was imported into the United States, as shown by the actual figures for ten months and an estimate for the remainder of the year. In January 963 short tons of white arsenic were imported, in February 773 tons, and in the next four months the imports increased to more than 1,000 tons a month. In August and September the imports decreased to 285 and 339 tons, respectively, but in October they increased to 652 tons. From January to October, inclusive, the imports amounted to 8,211 tons, valued at $1,487,609, or 9.06 cents a pound.

Mexico Contributes Largest Imports

Most of the white arsenic imported was produced in Mexico, but considerable quantities, in the order named, originated in Germany, Japan, Belgium, England, Canada, China, Dominican Republic and Australia.

The total white arsenic bought for consumption in 1924 from domestic and foreign sources was about 23,000 short tons, valued at 9 cents a pound. Manufacturers of insecticides purchased the largest quantities of white arsenic, and glass makers bought heavily during the last half of the year.

Sources of Domestic Arsenic

Twelve domestic arsenic plants were in operation in 1924. Two of them recovered white arsenic from ores and used it for making calcium arsenate, and one plant treated ozidized arsenical ore from which calcium arsenate was made directly. About 65 of the total refined and crude arsenic was obtained from ore roasted at seven arsenic plants primarily for its content of arsenic, 24 per cent was a by-product at copper smelters, and a little more than 9 per cent was a by-product at lead reduction works. At Midvale and Murray, Utah, arsenic plants operated separately from the main smelting works produced nearly half the total output. The plant at Midvale produced refined and crude white arsenic, which was used largely in making weed killer. Part of this product is made at Midvale and part at the plant of the United States Lead Refinery at East Chicago, Ind. The plant at Murray reduced arsenical ore to the crude product, which was shippped to Globe, Colo., for refinement. At the copper plant at Tacoma, Wash., refined white arsenic was made.

During 1924 more than 40,000 tons of arsenical ore, con-

taining an average of about 20 per cent of arsenic, was mined at Gold Hill, in the Clifton mining district, Utah. This output of ore was the largest made in the United States, and most of it was stockpiled for direct treatment at arsenic plants in the vicinity of Salt Lake City. Some of this ore was sent to the copper smelter at Tacoma, Wash.

Considerable arsenical speiss from the old smelter dump at Eureka, Nev., was shipped to Midvale, Utah, during the first part of the year, and part of it was stockpiled at Palisade, Nev., for future distribution. At the Toulon plant all the ore from the Irish Rose mine, near Battle Mountain, Nev., and considerable custom ore was reduced to white arsenic, but the plant was closed in June to await an increase in the price of arsenic. Elsewhere in Nevada arsenical ores were mined in the Manhattan, Antelope and Silver Star districts, at Holbrook, near Blair Junction, Carson City, and Fallon. The ores from these districts were treated at the arsenic plant at Martinez, Calif., which also received arsenical ore from Colorado, New Mexico and Arizona, as well as from mines in California. The white arsenic recovered from the ores roasted was made into weed killer (sodium arsenite), which was sold to railroad companies on the Pacific Coast. At Pittsburg, Calif., calcium arsenate was made from white arsenic recovered from ores purchased in Nevada and California. From the arsenic plant at Jardine, near Gardiner, Mont., considerable refined and crude white arsenic was sold and very little was left in stock. The plant is exceptionally well equipped, and when occasion demands can increase its output considerably. During the year new arsenic kitchens were completed at Keystone, S. Dak., and a little white arsenic was produced, conditions indicating a substantial production during 1925.

Prices Dropped Fifty Per Cent

The price of white arsenic in 1924, as quoted in journals published in New York City, ranged from 13½ cents a pound in January to 11¾ cents at the end of March and was about 8¼ cents during June and July. The price dropped gradually until October when 6½ cents was bid and 7 cents was asked. In November there was a slight demand, with offerings at 6¾ cents a pound delivered. The price of imported arsenic varied, with Japanese material at 6¼ cents a pound on spot in November and European at 6½ cents a pound.

Producers Can Meet All Demands

General interest in arsenic was evident near the end of 1924, but buyers who were looking for lower prices had been influenced by reports that large surplus stocks were being carried in the United States. That there are considerable stocks of arsenic is true, but they constitute only a small fraction of a good season's demand. Considerable ore containing arsenic is stockpiled at several points and can be held better in the crude ore than as the manufactured product. Most of the producers of white arsenic are in a position to produce heavily when there is a demand.

New Continuous Melting Tank of Novel Design

Some new ideas in the design of continuous glass melting tanks are embodied in the Simplex "Torpedo type" tank recently offered to the trade by the Simplex Engineering Company, who are sole agents in North America for this type of tank with its "Radiant Fire Ports," another new feature. The tank was designed by T. C. Moorhead, formerly chief engineer of the Illinois Glass Company, Alton, Ill., and is said to be in use in several large English glass plants.

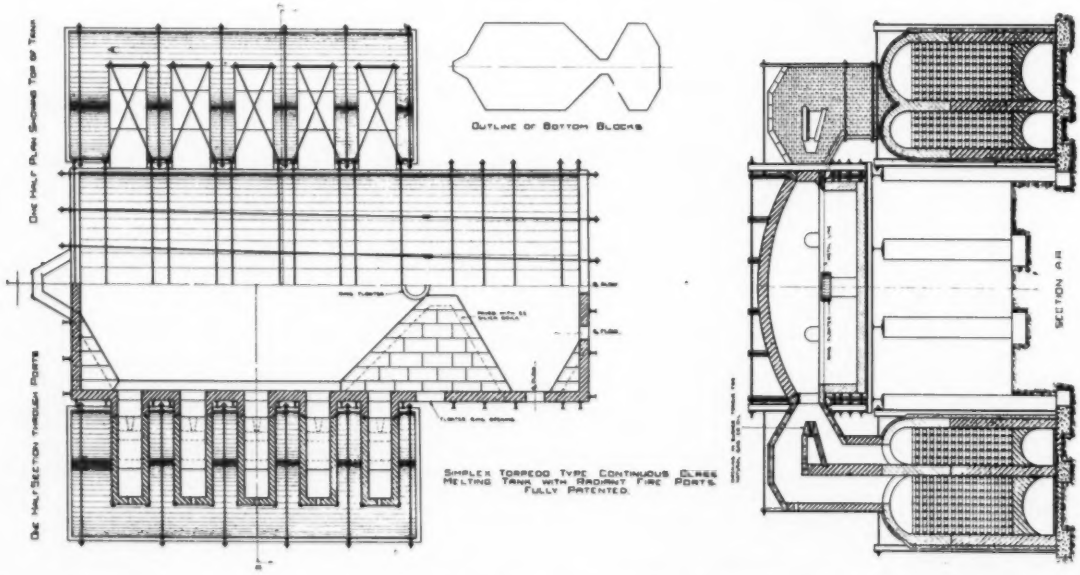
The name "Torpedo" was given to the tank because of its shape. The accompanying reproduced drawings show its construction in a general way. One of the main objects of the inventor was to eliminate devitrification caused by the liquid glass lying dormant in the corners of the tank. In the new tank this possibility has been greatly lessened by eliminating the corners, thus tending to produce a uniform flow of glass from the dog-house to the feeders.

The melting area of the tank has been reduced by avoiding corners yet, it is claimed, the innovation has not reduced the effective melting area nor lessened production in the least.

The other new feature, the "Radiant Fire Port," has been used in furnaces in three factories in this country for about three years. Ports installed in 1921 by the Simplex Engineering Company are reported to have been in excellent condition when inspected recently.

This port it is claimed completes the combustion of the fuel just before it enters the furnace, thus eliminating all flames in the combustion chamber of the tank, and melting glass by radiant fire rather than by any impinging or cutting action. The "Radiant Fire Port" tends to eliminate the deposit of carbon and any other matters in the glass.

The "Radiant Fire Port" is so designed that it forms a syphon through the ports which produces a positive flow of air from the regenerators to the ports. The oil or natural gas is introduced at the middle of the port, thus encompassing the fuel on all sides with preheated air, and bringing to the fuel complete and immediate combustion.


Outline of Bottom Blocks
Simplex Torpedo Type Continuous Glass Melting Tank with Radiant Fire Ports. Fully Patented.
Section A-B

A Billion Thousand Cubic Feet of Natural Gas Consumed in 1923

All records were broken in the natural-gas industry in the United States in 1923 by the consumption of 1,008,126,000,000 cubic feet, having an estimated value of 101 million dollars at the wells and of 240 million dollars at points of consumption, according to data compiled by H. Backus and issued by the Department of the Interior through the Geological Survey. This quantity is 32 per cent more than that consumed in 1922 and 26 per cent more than that consumed in 1920, when the previous high record of consumption was attained.

All the States that are large producers except New York and Indiana recorded increased production, as measured by deliveries to consumers, and in Oklahoma, California, and Louisiana gains in the quantity of natural gas delivered to consumers were made, ranging between 42 and 63 million cubic feet. In California enormous quantities of natural gas were produced, associated with petroleum, in the development of the Santa Fe Springs, Long Beach, and Huntington Beach fields, but the greater part of the gas produced in these fields was wasted. Operators reported

Natural Gas Produced and Consumed in the United States in 1923

State	Produced and Delivered to Consumers (Including Deliveries in Other States): Quantity (Millions of Cu. Ft.)	Estimated Value at the Wells: Total (Thousands of Dollars)	Estimated Value at the Wells: Average Per M Cubic Feet (Cents)	Consumed (Including Receipts from Other States): Quantity (Millions of Cu. Ft.)	Value at Points of Consumption: Total (Thousands of Dollars)	Value at Points of Consumption: Average Per M Cubic Feet (Cents)	Interstate Receipts and Deliveries: Quantity Piped Into State (Millions of Cu. Ft.)	Interstate Receipts and Deliveries: Quantity Piped Out of State (Millions of Cu. Ft.)
Arkansas	24,215	990	4.1	33,746	4,536	13.4	9,531	....
California	131,434	8,543	6.5	131,434	22,787	17.3	....	....
Illinois	4,049	587	14.5	4,049	690	17.0	....	....
Indiana	880	286	32.5	2,951	1,553	52.6	2,083	12
Kansas	32,072	2,707	8.4	37,637	10,829	28.8	11,627	6,062
Kentucky	11,953	1,039	8.7	21,232	5,605	26.4	9,279	....
Louisiana	112,031	2,890	2.6	111,434	5,127	4.6	8,643	9,240
Maryland	....	....	...	668	486	72.8	668	....
Missouri	17	3	17.6	6,301	4,152	65.9	6,284	....
Montana	1,470	59	4.0	2,417	521	21.6	947	....
New York	6,497	1,648	25.4	16,495	9,506	57.6	10,032	34
Ohio	53,812	8,395	15.6	120,920	58,468	48.4	70,770	3,662
Oklahoma	203,082	18,277	9.0	173,788	24,631	14.2	337	29,631
Pennsylvania	112,562	25,887	23.0	138,478	54,742	39.5	38,396	12,480
South Dakota	33	3	9.1	33	17	51.5	....	....
Texas	74,535	3,809	5.1	83,037	13,757	16.6	17,154	*b* 8,652
West Virginia	203,867	24,403	12.0	88,827	18,525	20.9	3,960	119,000
Wyoming	35,523	1,424	4.0	34,576	4,019	11.6	....	947
Other States (a)	103	9	8.7	103	10	9.7	....	....
1923	1,008,135	100,959	10.0	1,008,126	239,960	23.8	189,711	*b* 189,720
1922	762,546	84,873	11.1	762,546	221,535	29.1	179,332	179,332

a Alaska, Colorado, Iowa, Michigan, New Mexico, North Dakota, and Tennessee.
b Includes 9 million cubic feet of gas piped from Texas to Mexico.

Consumption of Natural Gas in 1923

State	Domestic Consumption: Number of consumers	Domestic Consumption: Quantity (millions of cu. ft.)	Domestic Consumption: Value at Points of consumption: Total (thousands of dollars)	Domestic Consumption: Value at Points of consumption: Average per M cubic feet (cents)	Industrial Consumption: Field (Drilling, pumping and Operating Gasoline Plants): Estimated quantity (millions of cu. ft.)	Industrial Consumption: Field (Drilling, pumping and Operating Gasoline Plants): Estimated value at points of consumption (thousands of dollars)	Industrial Consumption: Other Industrial, including use in Making Carbon Black: Quantity (millions of cu. ft.)	Industrial Consumption: Other Industrial, including use in Making Carbon Black: Value at points of consumption: Total (thousands of dollars)	Industrial Consumption: Other Industrial, including use in Making Carbon Black: Value at points of consumption: Average per M cubic feet (cents)	Industrial Consumption: Total Industrial: Quantity (millions of cu. ft.)	Industrial Consumption: Total Industrial: Value at points of consumption: Total (thousands of dollars)	Industrial Consumption: Total Industrial: Value at points of consumption: Average per M cubic feet (cents)
Arkansas	38,280	5,670	2,105	37.1	18,320	749	9,756	1,682	17.2	28,076	2,431	8.7
California	511,590	16,642	12,525	75.3	86,101	5,596	28,691	4,666	16.3	114,792	10,262	8.9
Illinois (a)	10,500	216	134	62.0	3,833	556	....	....	....	3,833	556	14.5
Indiana	36,300	1,624	936	57.6	47	15	1,280	602	47.0	1,327	617	46.5
Kansas	130,830	10,462	6,302	60.2	4,844	409	22,331	4,118	18.4	27,175	4,527	16.7
Kentucky	116,570	10,897	4,328	39.7	1,193	104	9,142	1,173	12.8	10,335	1,277	12.4
Louisiana	26,730	3,264	1,020	31.3	13,880	358	94,290	3,749	4.0	108,170	4,107	3.8
Maryland	11,290	587	443	75.5	....	....	81	43	53.1	81	43	53.1
Missouri	93,070	6,042	4,056	67.1	....	....	259	96	37.1	259	96	37.1
Montana	5,170	1,083	482	44.5	520	20	814	19	2.3	1,334	39	2.9
New York	197,540	16,009	9,300	58.1	217	55	269	151	56.1	486	206	42.4
Ohio	1,023,730	91,702	46,553	50.8	4,714	735	24,504	11,180	45.6	29,218	11,915	40.8
Oklahoma	142,700	17,496	8,436	48.2	114,948	10,345	41,344	5,850	14.1	156,292	16,195	10.4
Pennsylvania	548,440	58,968	29,614	50.2	10,027	2,304	69,483	22,824	32.8	79,510	25,128	31.6
South Dakota	380	33	17	51.5	....	....	....	....	....	....	....	....
Texas	177,070	13,002	8,406	64.7	51,876	2,651	18,159	2,700	14.9	70,035	5,351	7.6
West Virginia	154,060	22,806	6,884	30.2	20,252	2,424	45,769	9,217	20.1	66,021	11,641	17.6
Wyoming	9,350	1,632	734	45.0	12,279	493	20,665	2,791	13.5	32,944	3,284	10.0
Other States (b)	200	74	7	9.5	25	2	4	1	25.0	29	3	10.3
1923	3,233,800	278,209	142,282	51.1	343,076	26,816	386,841	70,862	18.3	729,917	97,678	13.4
1922	3,014,600	254,413	126,902	49.9	197,850	27,444	310,283	67,189	21.7	508,133	94,633	18.6

(a) Gas used with artificial gas. (b) Alaska, Colorado, Iowa, Michigan, New Mexico, North Dakota, and Tennessee.

to the Geological Survey a production of 248 billion cubic feet of gas in California in 1923, but of this amount only 131 billion cubic feet was delivered to consumers.

Industrial consumption of natural gas in 1923 increased to 72 per cent of the total, the increase being chiefly in field consumption and in the manufacture of carbon black, and the average price of natural gas used for industrial purposes decreased from 18.6 cents in 1922 to 13.4 cents in 1923 at points of consumption. Although the ratio of domestic to total consumption decreased, the number of domestic consumers increased 219,200 during the year, bringing the total to approximately 3¼ million, and the average price of natural gas used for domestic purposes increased from 49.9 cents in 1922 to 51.1 cents in 1923 at points of consumption.

The interstate movement of natural gas increased from 179 billion cubic feet in 1922 to almost 190 billion cubic feet in 1923. West Virginia, which contributed over 20 per cent of the total credited to production and consumed less than 9 per cent, contributed approximately 63 per cent of the total interstate movement of natural gas.

Summary of Statistics of Natural Gas, 1919-1923

	1919	1920	1921	1922	1923
Quantity of natural gas consumed (millions of cu. ft.):					
Domestic consumption	255,743	286,001	248,334	254,413	278,209
Industrial consumption:					
Carbon black	49,896	40,599	50,565	53,629	109,096
Field	169,787	202,108	182,305	197,850	343,076
Other industrial	270,490	269,502	180,848	256,654	277,745
Total consumed	745,916	798,210	662,052	762,546	1,008,126
Domestic (per cent)	34.3	35.8	37.5	33.4	27.6
Industrial (per cent)	65.7	64.2	62.5	66.6	72.4
Treated for natural-gas gasoline (millions of cu. ft.)	480,404	496,431	465,097	545,139	875,711
Per cent of total consumption	64.4	62.2	70.3	71.5	86.9
Domestic consumers	2,501,000	2,615,000	2,631,000	3,015,000	3,234,000
Value of natural gas at wells (thousands of dollars)	(a)	(a)	(a)	84,873	100,959
Average per M cu. ft. (cents)	(a)	(a)	(a)	11.1	10.0
Value of natural gas at points of consumption (thousands of dollars)	160,888	196,194	174,617	221,535	239,960
For domestic purposes	88,414	109,302	110,337	126,902	142,282
For industrial purposes	72,474	86,892	64,280	94,633	97,678
Average value per M cu. ft. (cents)					
For domestic purposes	34.6	38.2	44.4	49.9	51.1
For industrial purposes	14.8	17.0	15.5	18.6	13.4
Domestic and industrial	21.6	24.6	26.4	29.1	23.8
By-products of natural gas:					
Natural-gas gasoline:					
Quantity (thousands of gallons)	351,500	384,700	449,900	505,800	816,200
Value at plants (thousands of dollars)	64,197	71,788	61,815	72,711	77,268
Average value per gallon (cents)	18.3	18.7	13.7	14.4	9.5
Carbon black:					
Quantity (thousands of pounds)	52,100	51,300	59,800	67,800	138,300
Value at plants (thousands of dollars)	3,816	4,032	5,446	5,820	11,692
Average value per pound (cents)	7.3	7.9	9.1	8.6	8.5

(a) Figures not available prior to 1922.

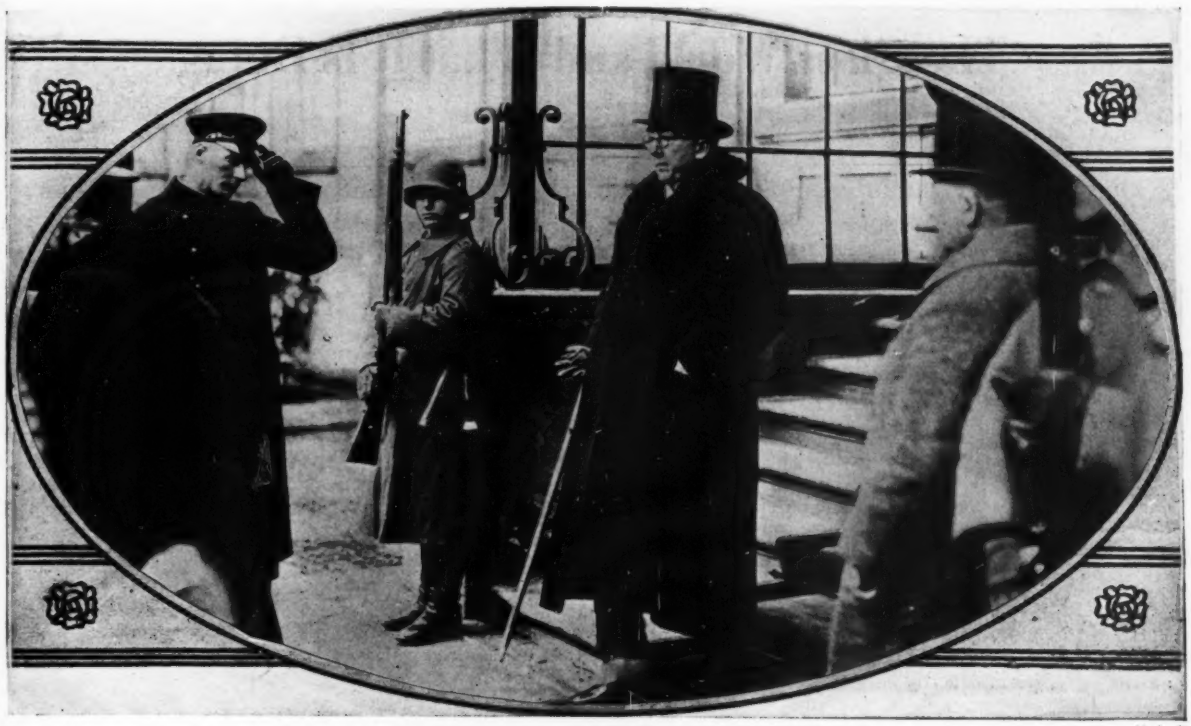
Forecasts Another Five Billion Dollar Building Year

One of the most interesting statistical developments in the building field during the past few years has been the Annual Building Survey and Forecast by *The Architectural Forum*. For the past three years, since the institution of this annual forecast, the *Forum* prediction as made the first of each year, has been within 3% correct when compared with actual figures at the end of the year. This forecast of building activity is based on a comprehensive survey carried out through individual reports from a large number of architects and from building contractors, bankers and others directly interested in the construction field. The investigation is made in 19 building types and covers each state.

Early in 1924 the *Forum* forecast (reviewed in THE GLASS INDUSTRY) predicted an expenditure of $5,560,367,700 during that year. The accompanying tabulation represents in detail the fourth annual survey covering the current year.

All evidence seems to bear out the prediction that 1925 is to be another record building year and that the great momentum of the building industry will continue almost unchecked.

Building Types	N. Eastern States	N. Atlantic States	S. Eastern States	S. Western States	Middle States	Western States	U. S. A.
Automotive	$13,038,000	$37,896,000	$3,381,000	$8,604,000	$53,691,000	$25,848,000	$142,458,000
Banks	6,939,000	79,770,000	6,255,000	13,791,000	46,431,000	16,935,000	170,121,000
Apartments	39,879,000	284,931,000	19,077,000	28,881,000	163,779,000	42,810,000	579,357,000
Apartment Hotels	15,030,000	69,270,000	7,275,000	14,670,000	75,165,000	21,945,000	203,355,000
Clubs (Fraternal, etc.)	31,020,000	107,028,000	7,455,000	13,689,000	121,317,000	41,283,000	321,792,000
Community (Memorial)	7,023,000	24,054,000	765,000	3,765,000	14,454,000	10,971,000	61,032,000
Churches	22,389,000	106,740,000	16,905,000	37,494,000	150,063,000	39,885,000	373,476,000
Dwellings (under $20,000)	15,837,000	109,281,000	10,809,000	11,904,000	64,497,000	23,394,000	235,722,000
Dwellings ($20,000-$50,000)	9,303,000	36,636,000	6,594,000	5,622,000	31,086,000	12,699,000	101,940,000
Dwellings (over $50,000)	4,710,000	21,717,000	1,620,000	4,635,000	15,036,000	7,812,000	55,530,000
Hotels	33,615,000	95,874,000	31,710,000	19,035,000	160,824,000	52,635,000	393,693,000
Hospitals	13,620,000	88,770,000	4,980,000	17,448,000	61,395,000	42,825,000	229,038,000
Industrial	37,770,000	115,089,000	7,191,000	13,698,000	178,050,000	40,569,000	392,367,000
Office buildings	39,303,000	222,441,000	12,426,000	36,039,000	103,359,000	75,051,000	488,619,000
Public buildings	8,103,000	51,981,000	4,911,000	12,666,000	51,510,000	57,930,000	187,101,000
Schools	79,335,000	263,784,000	27,291,000	51,687,000	229,641,000	75,120,000	726,858,000
Stores	15,630,000	45,030,000	4,965,000	6,708,000	41,685,000	23,220,000	137,238,000
Theatres	24,450,000	36,495,000	4,944,000	8,484,000	40,512,000	21,096,000	135,981,000
Welfare (Y. M. C. A., etc.)	1,353,000	18,417,000	1,305,000	6,171,000	15,096,000	14,298,000	56,640,000
Total value of new buildings	$418,347,000	$1,815,204,000	$179'859'000	$314,991,000	$1,617,591,000	$646,326,000	$4,992,318,000



United

ALANSON B. HOUGHTON, AMBASSADOR TO GERMANY, LEAVING THE BERLIN RESIDENCE OF PRESIDENT EBERT, AFTER AN OFFICIAL CALL

Eminent Glass Manufacturer Will Fill Nation's Most Important Post in Diplomatic Service

Widespread interest has been aroused throughout the glass industry and keen pleasure expressed by many of those connected with it over the announcement by President Coolidge during the past month that on March 4, 1925, Alanson B. Houghton of the Corning Glass Works, Corning, N. Y., United States Ambassador to Germany since 1922, would become Ambassador to the Court of St. James, London, the most important post in the diplomatic service, succeeding the present Ambassador Frank B. Kellogg of Minnesota, whose appointment to be Secretary of State, when Secretary Hughes retires, was announced some weeks ago.

The President's choice of Ambassador Houghton as his representative in England seems to have met with universal approval. The press has joined in acclaiming the appointment as a well deserved tribute to the Ambassador, both as a man and a diplomat, and the country at large appears satisfied that its affairs will be safe in the hands of a man whose business ability has been exemplified in the success of his own concern which stands at the very forefront of progress in the glass industry of the world, and whose success in national and international governmental affairs has been thoroughly yet unobstrusively demonstrated.

The daily press is filled with encomiums. Carter Field in the *New York Herald Tribune* writes as follows:

"Seldom, if ever, has the American system of choosing ambassadors and ministers to represent this country at foreign capitals resulted so happily from the standpoint of fitness for the task as has happened in the case of Alanson B. Houghton.

"The man who negotiated the Treaty of Berlin, the man who had so much to do with perfecting the Dawes plan and then with the even more difficult task of persuading the German people they ought to like it, the man who came back to this country on a vacation and turned the German vote from La Follette to Coolidge by a series of round table talks, was, just a few years ago, a business man and a scholar—neither a 'service diplomat' nor a politician.

"In one way of looking at it Mr. Houghton perhaps has the most amazing background of any man ever given a high diplomatic post by this country. He has never been a politician. He is not a 'gladhander.' He is not an orator. He combines the qualities seldom found in the same man, of being at once a keen and successful business man and a scholar.

"To his attainments in scholarship Lord Bryce, in his 'American Commonwealth,' paid tribute. So far as his business ability is concerned, he was for years the head of a glass factory at Corning, N. Y., which employs now more than 4,000 men, and has piled up a large fortune. He now has added to these normally widely separated qualities a reputation as a diplomat to which the old service men at the State Department pay high tribute. On top of it all, in the campaign last fall, he played a quiet, but tremendous, part.

"Up until 1918 Mr. Houghton was known to only a rather limited circle of business men and educators. As the head of a great glass factory and as a director of the Metropolitan Life Insurance Company he had attained considerable standing in the business world. As a graduate of Harvard and a post-graduate student at three foreign universities, Paris, Berlin and Goettingen, he had received some recognition in the scholastic world. But his name had never figured in newspaper headlines and politically he was almost unknown."

In 1918 Mr. Houghton ran for the House of Representatives in the thirty-seventh (Corning) district.

"He was elected," continues the *Herald Tribune* writer, "and on going to Washington his colleagues decided to put him on the Foreign Affairs Committee. The fact that this is an unusually good assignment for a new member is explained by two circumstances. One was that Mr. Houghton's knowledge of foreign affairs and ability were recognized by his colleagues at once, while the other was the extremely influential position in New York State politics of his brother-in-law, former State Senator William J. Tully.

'He was re-elected in 1920 in the Harding landslide and a still more remarkable acknowledgment of the recognition of his ability and the potency of Mr. Tully ensued. The New York Republican delegation, on being granted by the House steering committee another place on the Ways and Means Committee, unanimously voted to give this place to Mr. Houghton. When it is realized that the Ways and Means Committee is not only generally recognized as the most important committee in the House, but that it also has proved the ladder on which most of the leaders of the House have mounted, the significance of this makes itself apparent."

The Glass World and What It Is Doing

News of the Industry

Glass Men to Hear Interesting Papers and Discussions at Annual Ceramic Convention

Preparations are well advanced for the 1925 annual meeting of the American Ceramic Society, to take place February 16-21, inclusive, at Ohio State University, Columbus, Ohio, in connection with the national celebration of the thirtieth anniversary of the beginning of ceramic education in America. Ceramic manufacturing equipment and materials will be exhibited in Lord Hall and ceramic products will be shown in the museum building of the Ohio Historical and Archæological Association. The exhibit will be larger and more instructive than at any meeting of the society heretofore. Thirty producers of equipment and materials and forty ceramic manufacturers have already taken space and additional applications are being made.

One-and-a-half fares have been granted by the railroads and the Columbus hotels have set aside nine hundred rooms for the occasion. All of Lord Hall will be given over to the holding of the meetings, thus assuring the best possible arrangements for those attending to hear these papers in which they are most interested.

The tentative program for the ceramic anniversary celebration to be held at the University is as follows:

At the opening session, 10 A. M., Monday, February 16, an address of welcome will be given by President W. O. Thompson. Dr. Edw. Orton, Jr., will speak on "The Founding of the First Ceramic School." A. V. Bleininger will deliver an address on "Thirty Years Progress in Ceramic Education" and Dr. Edward R. Weidlein will describe "The Future of Ceramic Education."

At the afternoon session to be held at 2 P. M., Professor Charles F. Binns will discuss "The Value and Possibilities of Ceramic Education to the Craftsman," and Karl Langenbeck will speak on "The Early States of the Science of Ceramics in America."

Lantern slides will be shown depicting outstanding achievements during the past thirty years in the different ceramic fields, including glass and refractories, and also the development of ceramic education by the ceramic school. R. D. Landrum, president of the American Ceramic Society will address the meeting and make a statistical analysis of the ceramic industries.

A business session will be held and in the evening at 8 o'clock there will be a reception of presidents and representatives of ceramic schools. At 8:30 P. M. a stunt program by the students of Ohio State University will be given at the armory. Dancing will be indulged in until midnight.

On Tuesday evening, February 17, the annual banquet will be held.

On Thursday, Friday and Saturday visits will be made to various glass and ceramic plants in and near Columbus.

On Tuesday and Wednesday the seven divisions of the Society will hold separate meetings devoted to subjects of special interest to their members. For the Glass Division the following papers and discussions are scheduled:

Glass Division Program

1—Present and Future Walls for Use Against Molten Glass, by R. J. Montgomery.

2—Causes of Failure of Thermocouple Protection Tubes in Glass Furnaces, by H. Insley.

3—The Nature of Deposits on Glass Furnace Checker Brick, by H. Insley.

4—Effects of Composition on the Properties of Glass, by R. R. Shively.

5—The Use of Limestone in the Manufacture of Sheet Glass, by E. P. Arthur.

6—Keeping a Standard Flint Color, by J. W. Gayner.

7—Specific Gravity vs. Composition of Glass, by A. N. Finn.

8—The Viscosity of Glass, by A. N. Finn.

9—How May the Heat Economy (Fuel Efficiency) of Glass Furnaces be Increased, by E. R. Scholes.

10—Experience In Producing Durable Glass, by R. R. Shively.

11—Experiences in the Annealing of Glass, by A. N. Finn.

12—The Action of Arsenic Compounds on Tank Blocks, by D. J. McSwiney.

13—Joint Symposium with Refractories Division on Glass House Refractories.

Refractories Division Program

The Refractories Division program includes a symposium on glasshouse refractories under the leadership of Dr. J. C. Hostetter, of the Corning Glass Works, as follows:

1—Some Fundamental Principles Governing the Corrosion of a Fire Clay Refractory by a Glass, by Dr. R. B. Sosman. Replies by J. S. McDowell, Dr. Herbert Insley, Dr. McCaughey and A. B. Peck.

2—Fundamentals of Heat Flow in Molten Glass and in Walls for Use Against Glass, by Dr. G. V. McCauley. Replies by Dr. Van Dusen, M. L. Hartman, Prof. A. S. Watts, W. A. Morton, Dr. C. L. Norton, A. R. Payne, Dr. Arthur F. Gorton.

3—Present and Future Walls for Use Against Molten Glass, by R. J. Montgomery. Reply by Dr. Samuel R. Scholes.

4—Developments in Glass and Glass Industries Refractories During the Year at the U. S. Bureau of Standards, by R. F. Geller.

5—The Use of Muffle Tunnel Kilns for the "Arching" of Plate Glass Pots, by Philip Dressler and L. T. Strommer.

Twenty other papers are scheduled for the Refractories Division program, among which are the following:

Laboratory Tests on Plastic Refractories, by R. F. Geller.

A Study of the Factors Involved in the Spalling of Fire Brick, with Some Notes on Shrinkage, Reheating and Deformation Under Load, by M. C. Booze.

The Chemical and Physical Properties of Fire Clays from Various Producing Districts, by M. C. Booze.

Equilibrium Between Alumina and Silica at High Temperature, by N. L. Bowen.

Thermal Conductivity of Carborundum Refractories, by M. L. Hartman.

The Measurement of Expansion of Fire Brick at Various Temperatures, by F. A. Kohlmeyer.

European Silica Refractories, by Sanford S. Cole.

Effects of Red Hearths in Fire Clay Brick, by M. C. Booze.

Dry Press Fire Brick, by A. H. Krusen.

Co-Efficient of Expansion and Spalling of Highly Siliceous Fire Brick, by Dr. E. Endell.

Expansion of Joints in Furnaces and Kilns, by Charles F. Geiger.

Mineral Composition and Structure of Refractory Clays, by W. McCaughey.

Among the papers which will be presented and discussions that will be held in the Art Division are the following:

Relation of the Art Division to the Society, by Karl Langenbeck.

Art and Industry, by W. M. Hekking.

Industrial Art, by Charles R. Richards.

Discussion—The Commercial Decoration of Glassware, led by Theo. Lenchner.

Discussion—What the American Ceramic Society Holds Important to be Accomplished by Ceramic Divisions of Schools of Art, led by Mrs. Arthur F. Weaver.

Presentation of first two chapters of book, Ceramic Decorative Processes, by F. H. Rhead.

Ceramic Art and Design, by Dr. J. R. Hopkins.

Comprehensive programs have also been prepared for the Enamel, Heavy Clays, White Ware and Terra Cotta divisions.

Brown Alleges Infringement of Pyrometer Patents

A suit has been filed by the Brown Instrument Company, Philadelphia, Pa., in the District Court of the United States, Northern District of Illinois, against the Republic Flow Meters Company, Chicago, alleging that a new line of pyrometers recently brought out by the latter concern involves infringement of patents owned by the plaintiff company.

The bill of complaint alleges that certain former employes of the Brown Instrument Company who had knowledge of and were employed in connection with certain improvements and inventions in pyrometers that were being developed in the Research Department of the Brown Instrument Company conspired with the Republic Flow Meters Company and certain individuals connected therewith to enter into the employ of the Republic Flow Meters Company, and give that company the benefit of the confidential knowledge and information they had acquired of the improvements that were being developed by the Brown Instrument Company; and that they procured from the plaintiff's private and confidential records, blueprints and drawings, detailed information, specifications, records of sources of raw materials, etc., and imparted the information to the Republic Company who began to manufacture and market pyrometers which the plaintiff company claims are infringements upon patents owned by it. The plaintiff, therefore, asks for an injunction enjoining the defendants from manufacturing and selling pyrometers embodying the novel features developed at the plaintiff's plant or from using or disclosing any secret or confidential information, drawings, measurements, specifications, calibrations, charts, devices, or sources of materials of supplies, knowledge of which was obtained from the former employes of the plainiff; and also that the defendants pay to the plaintiff the profits or income derived from the alleged violation of the plaintiff's rights, and that additional damages be assessed against the defendants.

The Radio Industry and Glass

A survey of the radio industry completed during the past year by the Copper and Brass Research Association indicates that on the basis of an estimated total of 2,500,000 sets in use at that time, the number of radio sets in use in the United States will increase to equal the number of automobiles and telephones (viz: 15,000,000) and that this will likely occur in five years' time.

The radio industry has grown from practically a non-existent status only a few years ago to an industry with a sales volume of $115,000,000 in 1923, and sales made in 1924 are expected to add up to over $300,000,000. In another two or three years radio sales in the United States will undoubtedly reach the half-billion dollar mark.

Of the various items of radio equipment sales, vacuum tubes amount to a surprisingly large total. Their yearly volume accounts for at least 20% of the entire incandescent lamp sales for all purposes, and over 25% of all sales of radio merchandise.

The manufacturing end of radio is carried on by both individuals and corporations of all degrees of importance and output, from the lone individual "attic manufacturer" to the largest electrical manufacturing corporation. The real radio fan is continually making and remaking his sets, and this is reflected in the proportion of sales of parts to finished sets. About 75% of radio sales are for parts, and 25% for finished sets, so that even allowing for replacements to finished sets, the home-made set is numerically much more important.

Infringement Suits Started

The Owens Bottle Company, Toledo, has brought action in the Federal Court against Tucker, Reeves & Beatty and the Federal Glass Company, both of Columbus, alleging infringement on patent rights covering glass feeder apparatus. An injunction and accounting of profits are sought.

Suit to recover for alleged infringement of patents in connection with glass cylinder drawing apparatus has been filed in the U. S. District Court in the Western District of Pennsylvania by the Window Glass Machine Company and the American Window Glass Company against the Pittsburgh Sheet Glass Co.

A similar suit is reported to have been started by the same parties against the Baker Brothers Glass Co., Okmulgee, Okla.

Pittsburgh Glass Exhibit

This year's Pittsburgh Glass Exhibit, under the auspices of the Associated Glass and Pottery Manufacturers, running from January 5 to 24, started out a little more quietly than usual but soon developed more activity. Hundreds of buyers representing all sections of the country as well as a number from abroad visited the scores of exhibits prepared for their inspection. The demand for glassware of nearly all kinds was good and as usual many orders were placed with the manufacturers' representatives.

At the association's annual meeting, held on January 20, Charles H. West of Grapeville, Pa., was re-elected president. Other officers are: D. Harry Cushwa, Pittsburgh, vice-president; C. L. Sebring, Sebring, O., secretary; J. M. Hammer, Pittsburgh, assistant secretary and show manager; G. S. Brush, Zanesville, O., treasurer; directors, W. C. McCartney, Cambridge, O.; H. B. Duncan, Washington, Pa.; K. R. Bryce, Mt. Pleasant, Pa.; C. C. Ashbaugh, East Liverpool, O., and George C. Mitchell, Coshocton, O.

The annual banquet of the Western Glass and Pottery Association was held on the evening of January 13 with a very large attendance of persons interested in the trade. Announcement was made of the re-election of Reuben Haley, general manager of the United States Glass Company, as president for the current year, and of W. W. Lang of Kinney & Levan Company, as secretary and treasurer. Albert Binswanglo was elected first vice-president; J. W. Irwin, second vice-president; Francis I. Summers, third vice-president, and Henry W. Nickel, fourth vice-president.

Standard Invoice and Purchase Order Forms Adopted

At a national conference called by R. M. Hudson, chief of Division of Simplified Practice, Department of Commerce, and held on January 14, at Washington, D. C., standard forms for invoices, purchase orders and inquiries were adopted and recommended for the use of all branches of American industry and commerce. Forty-five organizations representing manufacturers, producers, distributors, consumers, railroads and other classes were represented. Among those which have been actively promoting the use of standard forms is the National Glass Distributors' Association, Optical Manufacturers' Association and the Refractory Manufacturers' Association.

It is estimated that an aggregate annual saving of over $15,000,000 would be made if invoices in all lines of business in the country were standardized. Copies of the standard forms mentioned above may be obtained from the Department of Commerce, Washington, D. C.

Dominion Glass Profits

The Dominion Glass Company, Montreal, report net profit for the year ended September 30 amounting to $753,369, compared with $724,664 in the preceding year. After usual charges for sinking fund and bond interest, the net income was $583,369, against $554,654. A balance of $401,369 was applicable to the common stock, equivalent to 9.44 per cent on the $4,250,000 of common stock outstanding, against 8.77 per cent in 1923 and 9.55 per cent in the record year of 1920. After common dividends, the surplus was increased by $103,860, making a total profit and loss surplus of $1,108,718.

Modern Producer Plants and Fuel Oil Burning Systems is the title of a new 8-page pamphlet issued by the Simplex Engineering Company, which is devoted to the subjects given in the title. Various points are referred to such as the proper velocity of producer gas in the mains, proper size of mains, importance of automatic gas pressure regulations, etc. A table is given showing the comparative value of fuels. The Simplex fuel oil burning system is described, installations of gas producers and fuel oil equipment are shown. Copies of the pamphlet may be obtained from the Simplex Engineering Company, Washington, Pa.

Trade Activities

The Indianapolis Glass Company, Indianapolis, Ind., will engage in the manufacture of mirrors on a large scale.

The Samuels Glass Company, 308 South Alamo street, San Antonio, Tex., is erecting a two-story building at an estimated cost of $20,000.

The Dominion Glass Company are reported to have let a contract for a building at their Hamilton, Ontario, factory to cost approximately $45,000.

The American Window Glass Company have lighted fires in tank No. 2 of their Kane, Pa., Plant. About 200 men will be employed when operated to full capacity.

The Weston Glass Company, Weston, W. Va., lost a tankful of glass on January 3 on account of the bursting of their large tank and were compelled to close down for several weeks.

The Rolland Glass Company, Clarksburg, W. Va., suffered some damage to their factory early in January when their main tank burst. Arrangements were made for immediate repairs.

The Southern States Bottle Company, Shreveport, La., are having notable success with a fine line of green soft drink bottles and expect at the end of this fire to inaugurate a program of extension.

The Myers Plate Glass Company, Inc., importers and jobbers of glass of all kinds and French mirror plate, etc., New York, has moved from 655 Second avenue, to its new four-story building at 503-05 East 82nd street.

The Standard Glass Company, Bremen, O., according to press reports, is considering extensive additions to their plant, including a new building 60 by 60 feet. The increased capacity, it is said, is needed to take care of the company's growing business.

The Simonel Mirror Plate Company of Evansville, Ind., has been incorporated with a capital of $75,000 to manufacture mirrors and deal in windshields and plate glass for automobiles. The incorporators are: E. Simonel, Sr., F. H. Mohr and Edward J. Sauer.

The Hygeia Nursing Bottle Company, Buffalo, N. Y., are building a new finished storage building at Lancaster, N. Y. This company manufactures nursery and all kinds of bottles. The contract calls for an Austin No. 1 standard building of steel frame construction.

According to an announcement made by J. W. Bosse, director of the industrial bureau of the Evansville, Ind., Chamber of Commerce, Dudley Williams, manager of the **Service Glass Company** of Indianapolis has decided to locate the company's plant in Evansville.

The Industrial Glass Company, 5225 Norwood Park avenue, Chicago, Ill., has been incorporated with a capital of $25,000 to manufacture and deal in art, plate and window glass, mirrors, etc. The incorporators are: Harry W. Gray, Anthony J. Daly and Clarence L. Mathison.

The Fairfield Sheet Glass Company, Lancaster, O., closed down early in January for cold repairs. The company operates a Libbey-Owens sheet glass drawing machine and the run just completed has been continuous for twenty months. Operations will be resumed very shortly.

Twin City Glass Company, Texarkana, Tex., manufacturers of window glass, announce through Leo Krouse, president, that fires have been started in their new plant and that they expect to begin operations within about thirty days. The company is using Pittsburgh Plate window glass machines.

The John B. Scohy Glass Company, Sistersville, W. Va., expects to have their installation of Fourcault machines completed and in operation about May 1. The company is at present operating their hand window glass plant to full capacity and reports that they are turning out a fine quality of glass.

The Turner Brothers Glass Company, Terre Haute, Ind., owing to increased business, are making improvements and additions to their plant which will give them an increase of 25 per cent over present capacity. A new lehr and automatic conveying machinery have been installed, also a new automatic sprinkling system.

William Swindell & Brothers, Pittsburgh, Pa., have recently completed the furnace construction for the National Plate Glass Company at Ottawa, Ill. This work consisted of eleven 20-pot melting furnaces, 6 pot arches and one lehr of the Cruikshank design as well as the lining of ten gas producers and the construction of all the underground flues from the producers to the furnaces.

Armour Louriaux, formerly manager of the Connolly Glass Company, Caney, Kans., prior to its destruction by fire last year, is reported to have purchased the Fredonia Window Glass Company, Fredonia, Kans., and expects to start hand operations during February under the name of **Loriaux Glass Company.** Mr. Louriaux is said to be planning the installation of window glass machinery.

The J. E. Marsden Glass Company, Ambler, Pa., has purchased the factory of the Spring City Bottle Company, Spring City, Pa. The plant is being remodelled and a new tank, lehrs and fuel oil system are being installed, for the manufacture of heat resisting glass. The Marsden Company is also erecting a new lehr at its Ambler plant, making a total of three lehrs and one continuous tank.

Kenneth P. Lockitt, 99 Bedford street, Boston, Mass., who until recently was connected with the Libbey Glass Manufacturing Company, Toledo, O., is now representing H. P. Sinclaire & Company, Corning, N. Y.; Hirsch-Malgood Company, Brooklyn, N. Y., and the Mound City Glass Company, Lumberport, W. Va., for the sales of their products in the six New England states, and also covering greater New York and adjacent territory for H. P. Sinclaire & Company.

The Wheeling Glass Manufacturing Company, Wheeling, W. Va., which acquired the plant of the North Wheeling Glass Works, last summer, according to press reports, expects to open up within the next month or two. The plant, which has not been in operation since it has been in the hands of the present owners, is being put in good condition and numerous repairs have been made. The products of the company will include a general line of glassware and shades.

The Consumers' Glass Company, Ltd., Montreal, Canada, went into operation January 19 with its large flint furnace which has an approximate capacity of 50 tons per day. Bottles of all descriptions will be made on Lynch and O'Neill machines. The furnace has been redesigned and rebuilt on modern lines and it is expected that greater efficiency will be obtained than during the last fire. Ray S. Godard, works manager, reports that the business outlook is very good and that the company is looking forward to a very big year.

The Columbia Glass Company, which began operations at their plant at Fairmont, W. Va., about the middle of January after a shut down of about two months for repairs, has completed the erection of a new regenerative tank. The company is now operating three automatic machines for the manufacture of opal containers, cream jars, soap dishes, etc., and expects to install another machine in the near future. The present improvements have cost about $25,000 and doubled the capacity of the factory. Glenn F. Barns, president of the company, reports that the outlook for the concern is very good.

The Vineland Flint Glass Works, Vineland, N. J., announce that they are now devoting one of their shops to the manufacture of iridescent glassware which will be known under the trade name of Durand Art Glass, after Victor Durand, owner of the works. Manufacturing operations in the new department are under the supervision of Martin Bach, formerly with the Quezal Art Glass and Decorating Company, Brooklyn, N. Y. The product will be the same as heretofore manufactured with many new additions. The New York show rooms will be located at 19 Madison avenue, with the Charles J. Dela Croix Company, who have handled this line for the past six years. Additional show rooms in other cities will be opened in the near future.

The Hocking Glass Company, at Lancaster, O., whose plant was destroyed by fire early last year, has been in production again for some time on high grade table ware. A much larger and more modern plant was built over the ruins of the old establishment. The plant is now comprised of three furnace buildings, three lehr buildings, a warehouse

building, a decorating building, an office building and two or three small units. At the present time the demands are such as to warrant the addition of a third floor to their decorating building. This building, like the others, is of fireproof construction and is 40 feet wide by 200 feet long, of reinforced concrete. The Austin Company, Cleveland, O., who designed and rebuilt the whole plant early in 1924, have been awarded a contract for the addition to the decorating department. The builders agreed to complete the work in 30 working days. Their prompt action after the fire enabled the Hocking Glass Company to resume shipments from their plant within 60 days after the fire occurred.

Personals

Edgar Gillot, who has been acting as president of the Window Glass Cutters' and Flatteners' Association of America, pending the result of a second ballot, the first having failed to elect a president, was formally elected to the office at a special meeting held in January.

C. H. Wright, formerly manager of the Clarksburg, W. Va., plant of the Pittsburgh Plate Glass Company, has been transferred as manager to the Mount Vernon, O., factory of the company. Mr. Wright is succeeded at Clarksburg by **Howard L. Halbach,** who was formerly tank foreman at that plant.

W. D. Pollock has been appointed superintendent of the Charleroi, Pa., works of the Macbeth-Evans Glass Company, succeeding L. P. Flickinger, who recently was granted a six-months leave of absence on account of illness. Mr. Pollock, who was factory manager and who has been with the company over forty years, has been succeeded by Lambert Heaton.

Carl S. Lamb was elected secretary of the Pittsburgh Plate Glass Company at a regular meeting of the board of directors held at Philadelphia on January 19. Mr. Lamb, who has been assistant general counsel for the company since 1910, succeeds C. R. Montgomery, who resigned on January 1 on account of ill health. He entered the employ of the company in its Chicago office in 1892 at the age of 18, working in all of the warehouse departments until he became credit manager of that branch. He attended night classes of the Chicago College of Law, graduating in 1899. He was one of the organizers of the law firm of King, Lamb & Gage, although still in the employ of the Pittsburgh Company. In 1907 he became assistant to the president, W. L. Clause, who is now chairman of the board. Mr. Lamb is also a director and secretary of the Chandler-Boyd Supply Company, a director of both the Missouri-Illinois Railroad and the Brown-Graves Co., of Akron, O.

Recent Deaths

Glenn G. Howe

Glenn G. Howe, for many years senior vice-president of the Link-Belt Company, Chicago, Ill., died on Christmas Day, 1924, after a long illness. His connection with the company began when he was sixteen years old. He was active for many years in organizing the company, extending its interests and carrying on its operations.

H. E. Smythe

H. E. Smythe, president of the S. R. Smythe Company, consulting engineers of Pittsburgh, Pa., died at his home January 9. Mr. Smythe, who was 60 years of age, was born in Dover, England, and came to this country in 1886. He and his brother, the late S. R. Smythe, organized the above firm of which he became president at the death of his brother. He is survived by his wife, two daughters and two sons.

Coming Meetings

AMERICAN CERAMIC SOCIETY annual meeting will be held at Columbus, O., February 16 to 21, 1925, inclusive.

NATIONAL ORNAMENTAL GLASS MANUFACTURERS' ASSOCIATION will hold its annual convention in Pittsburgh, June 24 to 26, 1925.

AMERICAN FLINT GLASS WORKERS' UNION, annual convention will be held the first week of July, 1925, in Toledo, O.

THE EASTERN GLASS DISTRIBUTORS' ASSOCIATION will hold its next meeting at the Hotel McAlpin, New York, Feb. 18, 1925.

THE CHICAGO EXHIBIT OF EASTERN MANUFACTURERS AND IMPORTERS OF GLASSWARE will be held at the Hotel Morrison, Chicago, Ill., February 2 to 14.

TENTH EXPOSITION OF CHEMICAL INDUSTRIES will be held at Grand Central Palace, New York, September 28 to October 3, under the management as usual of the International Exposition Company, 480 Lexington Ave., New York.

FIRST CHEMICAL EQUIPMENT EXPOSITION will be held at Providence, R. I., June 22 to 27, 1925, under the auspices of the Association of Chemical Equipment Manufacturers, 1328 Broadway, New York.

Inquiries Received

For Further Information, Address THE GLASS INDUSTRY

244. (From Roumania) Being interested in erecting a window glass plant I take the liberty of asking you who are the firms who own the different patents and furnish machines for making window glass (sheet-plate glass) mechanically. I know there are several systems like the Libbey-Owens, Fourcault process, etc., but I do not know who makes the machines or gives licenses for them. (Dec. 16).

245. We would like the names of a few of the largest manufacturers in this country of opaque glass. (Jan. 16).

246. We are planning to install a small furnace for melting glass. Please send us your recommendations.

What the World Wants

Specific inquiries for American goods received in the Department of Commerce.

Numbers prefixed to the items refer to confidential information which may be obtained by concerns listed in the Exporters' Index by applying to the nearest district office of the Bureaus of Foreign and Domestic Commerce, or to headquarters at Washington, D. C. Mention the number of the inquiry in which you are interested.

To become listed on the Exporters' Index, it is necessary to fill out a form (Form 57), which may be had upon application to the Bureau or its district or cooperative offices.

Canada. 13139, corks and glass bottles; 13356, glass for greenhouses.
China. 13118, high-grade cut glass.
Egypt. 13119, vacuum bottles.
India. 13122, tumblers.
Cuba. 13344, glassware and glass jars.
Chile. 13266, glassmaking machinery.
New Zealand. 13377, glassware of all kinds, household and industrial.
New Zealand. 13419, plate glass and special glasses, woven wire and safety glass.
Peru. 13479, colored, cathedral, opaline, Florentine glass.
Canada. 13503, beverage bottles and glass fruit jars.

Stock Quotations

(Reported by Moore, Leonard & Lynch, Union Trust Bldg., Pittsburgh, Pa.)

PITTSBURGH STOCK EXCHANGE, JANUARY 23, 1925

	Bid	Ask	Last
American Window Glass Machine, common	92½	94	93
American Window Glass Machine, pfd.	95	96	95
American Window Glass, preferred	113½	114½	114
Pittsburgh Plate Glass	270	285	275
Standard Plate Glass	15	15¼	15⅛

The glass stocks on the Pittsburgh Stock Exchange showed decided strength in the past month. Sales were in heavy volume. Excellent earning statements and the prospect that the glass industry has turned the corner and is definitely improving, are responsible for the activity. While the peak of new building in 1925 is expected to be under the high level of 1924, and 1923, it is nevertheless anticipated to be substantial. It is likely that the recent firmness in glass indicates the probability of firmer prices.

WHEELING STOCK EXCHANGE, JANUARY 26, 1925

	Bid	Ask	Last
Hazel-Atlas	33½	34	34
Imperial	75	78	88
Fostoria	140	..	140
Central	105	..	105

Wheeling market is sluggish. Plants are operating at about 55 per cent capacity, but expect improvement in February.

TOLEDO STOCK EXCHANGE, JANUARY 26, 1925

	Bid	Ask	Last
Owens Bottle Machine, common	46⅛	46¼	46⅜
Libbey-Owens Sheet Glass, common	102	106	103
Libbey-Owens Sheet Glass, preferred	109	..	110

Current Prices of Glass-Making Materials

Quotations furnished by various producers, manufacturers and dealers.

January 23, 1925

		Carlots	Less Carlots
Aluminum hydrate ($Al(OH)_3$)	lb.	.05	.05½
Aluminum oxide (Al_2O_3)	lb.	..	.07
Antimony oxide (Sb_2O_3)	lb.	..	.15
Arsenic trioxide (As_2O_3) (dense white), 99%	lb.	.05¾	.06¼
Barium carbonate ($BaCO_3$) (precipitated)	ton	63.00	65.00
Barium hydrate ($Ba(OH)_2$)	lb.	..	.05½
Bone ash	lb.	.06½	.07
Borax ($Na_2B_4O_7 10H_2O$)	lb.	.05	.05¼
Borax, fused ($Na_2B_4O_7$) any mesh	lb.	..	..
Boric acid (B_2O_3), fused	lb.	..	.35
Boric acid, refined	lb.	.09	.09½
Cadmium Sulphide (CdS)—			
Red	lb.	..	1.60
Orange	lb.	..	1.50
Yellow	lb.	..	1.80
Chrome Oxide (Cr_2O_3)	lb.	.35	.36
Cobalt Oxide (Co_2O_3)—			
In bbls.	lb.	..	2.10
In 10 lb. tins	lb.	..	2.20
Copper oxide—			
Red (Cu_2O)	lb.	..	.17
Black (CuO)	lb.	..	.25
Black prepared	lb.	..	.30
Cryolite (Na_3AlF_6)	lb.	..	.09⅛
Feldspar—			
100 mesh	ton	14.00	16.00
80 mesh	ton	12.00	..
40 mesh	ton	12.00	..
Fluorspar (CaF_2)—			
Powdered white, 95%	ton	38.00	..
Hydrochloric acid (20°) (Carboy $5)	lb.	..	.02
Hydrofluoric acid (HF) 60% (in lead carboys)	lb.	..	.13
52% and 48%	lb.	..	.10½-.11
Kaolin (f.o.b. mine)	ton	9.00	12.00
Lead Oxide (Pb_3O_4) (red lead)	lb.	.13¾	.13¾
Litharge (PbO)	lb.	.13¼	.13¼
Lime—		Carlots	Less Carlots
Hydrated ($Ca(OH)_2$) (in 50 lb. paper sacks)	ton	11.00-12.50	..
Burnt (CaO) ground, in bulk	ton	9.00	..
Burnt, ground, in paper sacks	ton	11.00	..
Burnt, ground, in 280 lb. bbls. per bbl.		2.15	2.30
Magnesium carbonate ($MgCO_3$)	lb.	..	.08
Manganese 85% (MnO_2)	lb.	.04½	.05½
Nickel oxide (Ni_2O_3), black, for nickel content	lb.	..	.35
Nickel monoxide (NiO), green, for nickel content	lb.	..	.35
Nitric acid (38°) (Carboy $5)	lb.	..	.06
Potassium carbonate—			
Calcined (K_2CO_3) 96%	lb.	.06	.06½
Hydrated 85%	lb.	.05½	.05¾
Potassium nitrate (KNO_3) (gran.)	lb.	.06	.06¼
Potassium permanganate ($KMnO_4$)	lb.	.14½	.16
Powdered blue	lb.	..	.24
Standard formula	lb.	..	.32
Rochelle salts	lb.	..	.20
Salt cake, glassmakers (Na_2SO_4), f.o.b. works	ton	25.00	27.00
Selenium (Se)	lb.	..	2.20
Silver nitrate ($AgNO_3$) 100 oz., per oz.		..	.43¾
Soda ash (Na_2CO_3) dense, 58%— f.o.b. works.			
Bulk, spot	Flat 100 lb.	1.35-1.40	..
Bulk, on contract	Flat 100 lb.	1.35	..
In 400 lb. bbls., on contract	100 lb.	1.69	2.40
In 400 lb. bags, on contract	100 lb.	1.45	..
Spot orders .05 per 100 lbs. higher.			
Sodium nitrate ($NaNO_3$),			
Refined (gran.) in bbls.	lb.	.04¼	.04½
95 per cent		.02⅝	.02¾
Sodium selenite (Na_2SeO_3)	lb.	..	2.00
Sodium Fluosilicate (Na_2SiF_6)	lb.	..	.07½
Sulphur (S)—			
Flowers, 155 lb. bbl.	Per 100 lb.	3.35	3.65-3.90
Flowers, in bags	Per 100 lb.	3.00	3.30-3.55
Flour, heavy, in bbls.	Per 100 lb.	2.40	2.85-3.05
Uranium oxide (UO_3), 100 lb. lots	lb.	..	1.25
Zinc oxide (ZnO)	lb.	.08	.08¼

Monthly Summary of United States Foreign Commerce in Glass

EXPORTS

Corrected to December 24, 1924

	November 1923 Quantity	November 1923 Value	November 1924 Quantity	November 1924 Value	Eleven Months Ending November 1923 Quantity	Eleven Months Ending November 1923 Value	Eleven Months Ending November 1924 Quantity	Eleven Months Ending November 1924 Value
Glass and glass products (total)	.....	$943,026	.....	$759,920	.....	$10,126,812	.....	$8,089,847
Plate and window glass—								
Window glass, common, box 50 sq. ft.	3,699	19,399	7,729	29,845	40,602	220,803	38,980	175,304
Plate glass, unsilvered, sq. ft.	66,256	22,826	158,884	38,672	1,833,586	787,889	1,603,944	475,108
Other windows and plate glass, n.e.s. lbs.	173,353	19,369	112,301	12,186	3,171,399	354,140	1,906,596	202,762
Glass containers (bottles, vials and jars) lbs.	5,807,751	292,325	5,021,418	236,730	68,522,958	3,267,455	56,075,668	2,662,266
Table glassware, plain lbs.	2,129,924	243,080	1,281,750	139,858	19,130,085	2,102,633	15,255,556	1,639,919
Table and other glassware, cut or engraved lbs.	44,696	15,433	73,995	20,994	515,470	196,307	511,437	155,219
Glass for lighting—								
Lamp chimneys and lantern globes lbs.	204,325	35,031	158,091	27,019	1,849,298	358,068	1,766,987	327,409
Globes and shades for lighting fixtures lbs.	215,470	49,210	181,706	41,368	1,498,297	436,036	1,276,631	369,057
Lamps and other illuminating devices, chiefly of glass lbs.	168,522	30,582	101,784	41,033	1,449,542	362,363	938,120	280,983
Chemical glassware lbs.	22,085	17,854	20,622	16,104	228,023	161,420	222,267	178,863
Electrical glassware, except for lighting lbs.	202,126	12,433	173,124	24,589	2,503,488	166,548	2,315,326	232,397
Other glassware, n.e.s. lbs.	980,155	185,484	508,458	131,522	9,604,529	1,713,150	7,910,847	1,390,560

IMPORTS

Corrected to December 24, 1924

Glass (total)	.....	$1,980,956	.....	$1,372,240	.....	$22,876,169	.....	$18,015,723
Cylinder, crown and sheet lbs.—								
Unpolished, lbs. dut.	1,622,052	94,848	1,873,985	114,773	43,176,855	1,928,398	28,434,337	1,633,435
Bent, ground, leveled, colored, painted, etc., and polished dut.	.....	60,141	.....	60,231	.....	730,589	.....	477,398
Plate glass—								
Unsilvered, sq. ft. dut.	1,981,186	1,253,086	1,025,769	512,862	24,299,128	14,728,050	15,834,283	9,461,823
Fluted, rolled, etc., or silvered, or containing wire netting, sq. ft. dut.	77,750	15,913	111,181	20,375	1,970,922	337,659	2,386,618	333,699
	.....	10,042	.....	15,896	.....	185,367	.....	192,768
Containers—bottles, vials, etc. dut.	79,285	25,246	94,331	28,792	601,842	158,394	841,771	195,294
Table and kitchen utensils, lbs. dut.	287,734	163,687	363,696	192,358	3,329,235	1,339,360	3,687,996	1,760,694
Glassware, cut or decorated, lbs. dut.	470,759	176,735	.....	.....	5,948,577	1,360,828	.....	.....
Blown glassware, n. e. s., lbs. dut.	.....	.....	899,848	219,841	.....	.....	6,180,685	1,771,810
Bottles, ornaments, etc., lbs. dut.	.....	.....	2,293,317	22,195	.....	.....	14,738,020	206,974
Bulbs or electric lamps, number dut.	.....	.....	288,387	90,347	.....	.....	4,189,318	821,981
Chimneys, globes, shades, etc., lbs. dut.	.....	.....						
Articles and utensils for chemical, scientific, and experimental purposes, lbs. dut.	.....	.....	76,714	20,614	.....	.....	916,703	310,478
Other glassware { free	.....	181,258	.....	73,956	.....	2,107,524	.....	849,369
{ dut.								